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EVERYTHING PNEUMATIC.

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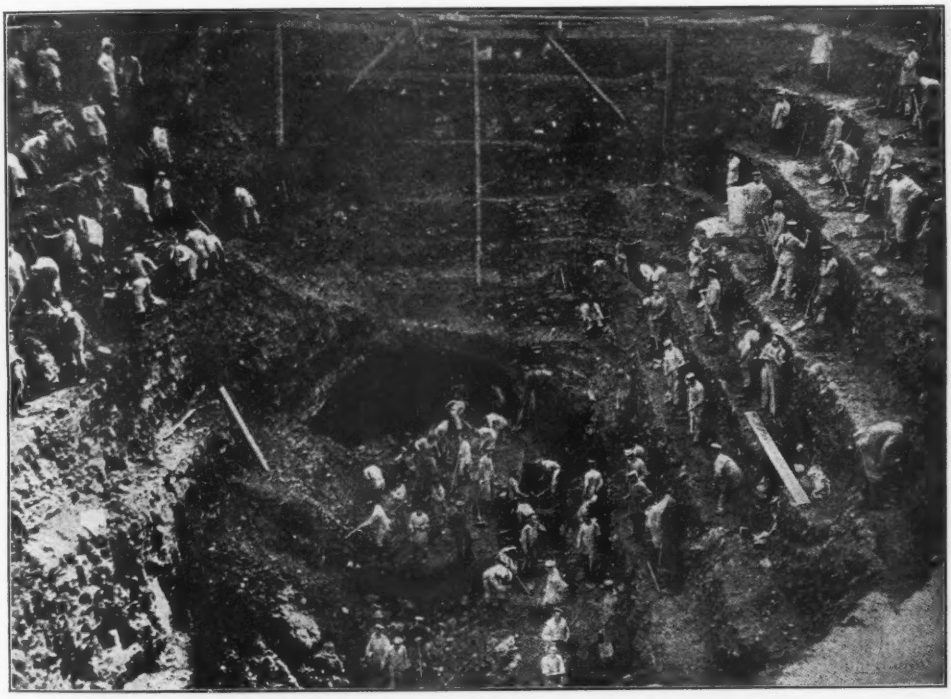


GERMAN SOLDIERS DIGGING OUT A TUNNEL.

WAR ENGINEERING

Without the engineer the World War would have been impossible, which fact for the moment suggests some doubts as to the ultimate beneficience of the profession. But in peace as well as in war we cannot live without him, so that, whatever is going on, he is as sure of his job as the butcher or the baker, and no matter what the task he finds a way to do it.

The half tone above reproduces what must have been, under the circumstances, an excellent photo, and though it has suffered from a repeated reproduction it still tells its story better than any words. We are not permitted to know the exact location of it, but it happened that a correspondent of the *New York Times* passed the spot in going from the German Great Headquarters along a main line of communication through eastern France, across a corner of Belgium and so on through Luxemburg. The French had blown up, or blown in, a two track railway tunnel and the German soldiers were digging it out.

The writer on the spot tells us: "One track has been cleared but the going is still bad. To keep it from being blocked again by falling debris the Germans have dug clear through to the top of a hill, opening up a deep well of light into the tunnel. Looking up you see a pioneer company in once cream-colored, now dirt-colored fatigue uniform still digging away and terracing the sides of the big hole to prevent slides." The terracing spoken of was to give standing room for the successive tiers of shovelers.

The correspondent's story continues: "Half an hour later we go slow again in crossing a new wooden bridge over the Meuse—only one track as yet. It took the Germans nearly a week to build the substitute for the old steel railway bridge where five spans lie buckled up in the river. The pioneers are at work driving piles to carry a sceond track. A forty-man-power pile driver is rigged on the bow of a French river barge, with forty soldiers tugging at forty strands of the main rope." Further along a new branch line is being built, "You half expect to see a swearing Irish foreman. It looks like home—all except the inevitable officer (distinguished by revolver and field glass) shouting commands." There is no end to the story and no rest night or day.

A TUNNEL PAYS THE COST OF ITS OWN CONSTRUCTION

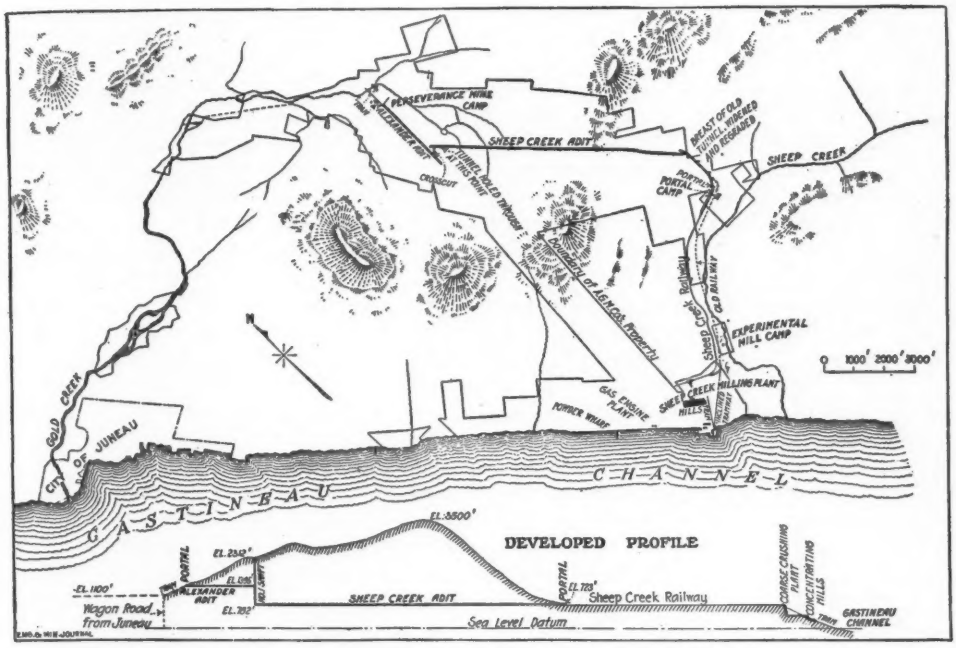
On October 29th the Mayor of Baltimore diverted the flow of Jones Falls, a small meandering stream running through the heart of Baltimore, into a tunnel built in conjunction with what is known as the Fallsway, thus forever burying an old open sewer, which has been an eyesore to the city. The remarkable feature of the improvement is that though it cost two million dollars and is for general public use, and not for a restricted measured service that can be charged for, it will eventually cost the city nothing. The increased taxes derived by the city from the creation over the stream of a new north and south street, running from the heart of the business district to the railroad depots, affording a traffic artery on easy grades, will pay the interest on bonds necessary for its construction and create a sinking fund to redeem them. The back lots of the properties backing on the old stream have been converted into valuable, desirable lots for business purposes facing this broad new boulevard. The work is a marked tribute to the man who conceived it, Calvin W. Hendrick, and is suggestive of possibilities in other cities. Had the stream been a wide one, with good water depth throughout the year, the improvement of its shores for shipping or for recreational purposes would have been advisable. Jones Falls, however, had a depth of water only in the spring, and for the rest of the year was a series of puddles. Under these conditions its conversion into a highway beneath which are three channels for carrying the flow was a most happy solution for ridding the town of a physical deformity.—*Engineering Record.*

POTASSIUM AND POTASH

The U. S. Geological Survey gives out the following to meet the numerous inquiries concerning the exact meaning of the terms "potash," "actual potash" and "potassium."

The element potassium, represented by the symbol K, is the basis of all potash salts or compounds. This substance is a metal; that is, it possesses metallic properties. To prevent rapid change it must be kept from air and water, with both of which it combines with great avidity. Combined with oxygen it forms potassium oxide, represented by the symbol K_2O, known as potassa, but popularly as "potash." In estimating the quantity of potassium in the different products of the Stassfurt deposits, this compound, K_2O, is employed as a standard, the object being to establish a basis of comparison for all potassium salts. Among chemists as well as laymen there has grown up the practice of using for this standard the term "potash." When only the term "potash" is used in speaking of potash products, it is understood to refer to the potassium oxide (K_2O) present. As a matter of fact, however, potash salts are not sold in the form K_2O, but as the sulphate or the chloride. By the term "potassium sulphate" is meant potassium (K) combined with the acid radicle of sulphuric acid (SO_4), or potassium oxide (K_2O) combined with sulphur trioxide (SO_3), making the compound K_2SO_4. By "potassium chloride" is meant potassium (K) combined with another element, chlorine (Cl).

The boilers of the U. S. battleship Nevada, recently launched, of the oil-fired Yarrow type, are to carry 295 lb. gage pressure.



PLAN AND PROFILE OF TUNNEL AND CONNECTIONS.

DRIVING SHEEP CREEK TUNNEL

The following is an abstract of a remarkably able and satisfactory report of an unusually interesting tunneling operation in Alaska. The report was prepared by the engineering staff of the Alaska Gastineau Mining Company and communicated to the *Engineering and Mining Journal* by the managing director of the Alaska Gold Mines Company, and the excellent abstract which appeared in that publication is here presented in a still more condensed form:

The Sheep Creek tunnel was part of the development program of the Alaska Gastineau Mining Company, at Juneau, Alaska. The Alaska Gastineau is the operating company of the Alaska Gold Mines Company. The tunnel was driven to develop the lode, and to form part of the transportation system between the mine and the 6,000-ton mill under construction on the shore of Gastineau Channel.

The portal of the tunnel is 723 ft. above sea level and 7,250 ft. distant from the coarse-crushing plant of the mill. Its underground terminal is its intersection with the main or No. 1 shaft of the Perseverance mine, 1,530 ft. below the surface and 613 ft. below the Alexander level, previously the lowest working adit on the Perseverance property.

A good deal of preliminary work was necessary before the actual driving of the tunnel was begun. A camp with warehouses, etc., was established on Gastineau Channel. From this point a 2,200-ft. inclined tramway connected at an elevation of 650 ft. with an old narrow-gage railroad or tramway, which ran along the side of Sheep Creek Basin to the old mine. This railroad was built entirely on trestles which had to be strengthened and rebuilt.

THE TUNNEL CAMP.

A camp was established at the end of the narrow-gage railroad near the entrance to the tunnel. There was a three-story rooming house, 20x66 ft., and a one-story mess house, 24x66 ft., containing dining room, kitchen, storeroom and in the basement a room for the fire-fighting apparatus. A third building was used for a change room on the lower floor and a club room on the second. The change room was equipped with steam-heated lockers, bathrooms, shower baths and lavatories. The club floor had a reading room, writing room, card room and assembly room. The central heating plant was located in the power house. The tunnel foreman had a cottage, and another small building provided

sleeping quarters for the cooks and mess-house help.

The blacksmith shop was 24x50 ft., equipped with two forges, one No. 5 Leyner-Ingersoll sharpener, benches, tools, etc., and an air hammer made from a 3¼-in. piston machine. The carpenter shop was 12x24 ft Adjacent to the two shops was a storeroom, 12x30 ft., for spare drill parts, fittings and miscellaneous supplies.

The powder magazine was on the railroad track about one-half mile from the tunnel. An auxiliary magazine and thawer was situated about 150 ft. from the tunnel entrance with which it was connected by a covered passage. All powder was thawed in the original boxes by electricity and was taken to the face in the same boxes, except that made into primers; the primers were made up in this auxiliary magazine.

COMPRESSORS, DRILLS AND VENTILATING SYSTEM.

The compressor was an Ingersoll-Rand, Imperial, type 10, cross-compound, 22 and 13x16-in. machine, belt driven by a General Electric, form K 200-hp., 2,200-volt induction motor. The air left the receiver at 105 lb. and was carried in 7-in. casing pipe for about half the distance to the end of the tunnel and in standard 6-in. for the remainder. Flange unions were used throughout to facilitate making connections.

An exhaust ventilating system was used. The first fan placed just outside the tunnel, was a No. 5, Type K, American Blower Co. exhaust machine, belt-driven by a 20-hp. motor at a speed of 3,000 r.p.m., and delivering 3,000 cu. ft. of free air per min. against a 12-oz. pressure. At 3,000 ft. in a second fan, built by the Lewis Burton Co., was installed in series to handle the same amount of air against an 8-oz. suction; it was belt-connected to a 15-hp., 1,740-r.p.m. induction motor. At intervals of about 2,550 ft., additional fans of the same size and type were installed. A 15-in. ventilating pipe was made up of 18-gage galvanized iron in 25-ft. lengths. The lengths were provided with slip joints with lugs for wiring them together; all joints were wrapped with tarred canvas to insure their being air-tight. The series operation of the fans was intended to eliminate the necessity of heavy pipe to resist collapse, and also to reduce the leakage along the line.

The drills were Ingersoll-Rand E 44, 3¼-in. piston machines. Six were kept on hand, four at the face, one in the tunnel and one in the shop being overhauled. In use they were mounted on 4½-in. horizontal bars 9 ft. long. Of the drill steel the starters were made of 2-in. cruciform, with 2¾-in. gage, 32 in. long. The seconds were of 1¾-in. cruciform, with 2½-in. gage and 52 in. long; the last three pieces were made of 1½-in. steel, gages $2^{8}/_{16}$-in., 2⅛-in. and $1^{15}/_{16}$-in., length 74-in., 94-in. and 116-in. About 750 pieces were kept up, sharpening being done on the day shift only and over 500 pieces frequently being dulled per day.

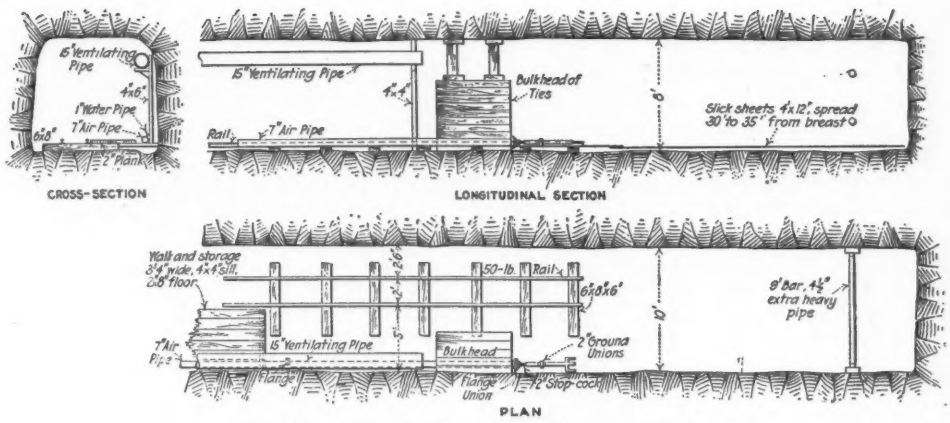
FEATURES OF THE TUNNEL.

Of the total tunnel length, 474 ft. was driven through slide rock and gravel near the portal; 4,009 ft. in greenstone, 4,224 ft. in slate and 1,085 ft. in metagabbro; the last three rocks alternated, the stretches varying from a few feet, up to several thousand.

In general the direction of the tunnel followed the strike of the formation, making it difficult to break the rock, especially the hard silicified slate, where the effect of the cleavage planes was marked. The holes broke short and a great many were required. Greenstone also developed cleavage planes in places with a similar result. When the tunnel was in homogeneous blocky greenstone, the rate of progress jumped to about a foot per hour, and there is no doubt but that if the entire distance had been driven in such rock, the record made would have been improved by at least 25 per cent., and the costs correspondingly reduced. In general, shallow rounds giving an average advance of 4 ft., were found to be most economical and rapid.

The tunnel was 10 ft. wide and 8 ft. high, with a small ditch along one side. Timbering was necessary only in the loose ground near the portal, and at this point the section was kept 8x10 ft. inside timbers. From the solid rock face from which the main tunnel started to its intersection with the crosscut from the Perseverance shaft, the distance is 8,800.5 ft.; 240 ft. of branch tunnel was also driven by the same crew. The relations of the different parts of the tunnel, as well as surface construction, are shown in the accompanying map and profile.

The tunnel was driven for single track its entire length, with the intention of widening out for sidings later. The average upgrade from the entrance was 0.65 per cent., based



SECTIONS AND PLAN OF HEADING ARRANGEMENTS.

on questions of drainage and equalization of tractive effort with loaded and empty cars.

FORCE EMPLOYED AND SHIFT ARRANGEMENT.

The force employed consisted of 70 men. Working on day shift only, there was a general foreman, a time-keeper, a tool sharpener, tool-sharpener helper, a blacksmith, a blacksmith helper, a carpenter, an electrician, a powderman, and an outside man. Two compressor men worked 12-hr. shifts each. Divided into three shifts there were three shift bosses, 12 upper-bar machinemen, 12 lower-bar machinemen, 18 muckers, three carmen, three locomotive engineers, three locomotive brakemen and four pipe- and trackmen.

The arrangement of shifts was unusual. The cycle was completed in 18 instead of 24 hr.; during this time each of the three crews into which the force was divided worked 6 hr. and rested 12, so that in each 24 hr. there was 8 hr. of work for each man. The incoming shift would relieve the outgoing shift at the working face and there was no intermission in the work for the purpose of eating a meal; this eliminated the delay of the meal time and the slackening of work following heavy eating. The plan was eminently successful and acceptable to the men; the only objection was the complication in the meals at the boarding house; eight meals had to be served every 24 hr., two for each 6-hr-shift; each shift got a meal about three-quarter of an hour before it went on and another when it came off.

ROUTINE OF DRILLING.

After spitting the round, the men walked back in the tunnel about 1,000 ft. The holes were counted and immediately after the last lifter went off the men started toward the face again. The fans being in full operation continuously, no smoke was encountered until within about 60 ft. of the face. One man then carried to the breast a water hose, previously connected to the water line and sprayed the muck. Meanwhile the manifold was connected to the air line and the air hoses attached thereto. The top bar was next brought up and jacked into place; two machines were placed on the bar, the air hose connected as soon as possible and drilling started. At the beginning of tunneling operations it required about 30 min. from the time the last lifter was fired until the top-bar machines were running. By the end of the undertaking, this took frequently only 10 min. and seldom more than 15.

With the top machines in operation, the four lower-bar machinemen started mucking out to make room for the lower bar. They threw back to the slick sheet, from which the muckers loaded into the cars. It was usually possible to set the lower bar and finish drilling the lower holes by the time the top machines were finished, so that all of the machines were torn down together.

ROUTINE OF MUCKING.

While the machines were being placed in position, mucking began. The empty car was brought ahead and the track cleaned up to the slick sheet. Of the six muckers, four were shoveling continually and two resting. The average output of the force was 10 to 12 tons per hour. On a slick sheet beside the track, within 50 ft. of the face at all times, an empty car was kept. Whenever a car was load-

ed, the carman took it down the track and brought back the empty. There was thus only a fraction of a minute lost in changing cars. A few hundred feet back from the face another slick sheet was maintained and when the locomotive brought in a train of empties, they were thrown off the track on this sheet. The loaded cars were run back to this point, made up into a train and hauled out. From this latter sheet, the empty cars were run one at a time up to the sheet near the face. The empty cars weighed about 1,100 lb. and were hauled by a man using a crowbar. The sheets were kept about the same height as the top of the rail so that the car required to be lifted only the height of the flange. No switches were used anywhere. At no time did the removal of the muck limit the speed of drifting or interfere with the drilling cycle.

The steel plates used for the slick-sheet sidings were ¼x48x140 in. The siding some distance from the face was 48 to 60 ft. long; directly opposite it were ¼x22x140-in. sheets, resting on planks down the center of the track, and also flush with the rail heads.

TRACK-LAYING.

After practically all the muck was cleaned out, the shovelers laid ties to grade as the tunnel advanced, thus facilitating the subsequent laying of the rails. A 25-ft. false track was advanced over the ends of the rails as necessary, so that the cars were always next to the muck pile. When the advance permitted the insertion of a set of rails, the foreman and muckers did the work in 15 to 20 min., without disturbing the machinemen.

BLASTING

On the completion of the round, shovelers, machinemen and everybody helped to tear down the machines and bars. Then ¼x36x140-in. slick sheets were spread out for 30 ft. back from the face and covered with a little muck. These sheets were handled with grappling hooks through holes in each corner. When the machines were removed, an air hose was attached to a blow pipe and the holes cleaned. The shift boss, machinemen and foreman then did the loading. Double fuse was used on the lifters. The explosives were Bear Brand fuse, California 8X caps and Hercules E. L. F. extra 60 per cent. powder. Spitting the fuses completed the cycle. There is no relation whatever between the shift and the drilling cycle, the machinemen relieving each other without stopping drilling.

Operations	Time Consumed Min.
Returning to face	4
Setting top bar	6
Mounting and starting up two machines	3
Shoveling back for bottom bar	30
Drilling 20 to 25 holes	210
Tearing down machines	5
Blowing out holes	4
Loading holes	6
Cutting and spitting fuses	2
Interval to report of first hole	4
Interval from report of first hole to report of last	3
Total	4 hr. 37 min.

Beginning with the time the last hole was heard to explode, the average time schedule for the last five months' operations would be about as follows:

THE ROUND.

In drilling the round the standard center cut, generally with six holes, was used; these cut holes varied from 7½ to 8 ft. The side holes and lifters, which averaged 5½ ft., were put in to suit the ground. Variations in the nature of the formation necessitated a good deal of variation in the layout of the holes. A good many relievers and "kickers" were frequently necessary. The usual round required 21 to 23 holes, although at times 29 were necessary. For a 22-hole round the total footage was about 140; the average rate of drilling dry holes was 6 ft. per hr., of drilling wet holes, 7 to 10 ft. per hr.; the average time for a complete round was 3½ to 5 hr.; the average advance per round was about 4 ft.

TRAMMING.

The muck from the face was hand-trammed at first, subsequently a storage-battery locomotive was used, transporting material, men and waste rock. The Matheson side-dumping roller-bearing cars had a capacity of 30 cu. ft. Drill steel and miscellaneous material were handled principally on small flat cars. The 30-ft. capacity cars were the largest that could be used on the slick-sheet sidings. They were loaded heaping full, since when loaded they did not require to be derailed. The track gage was 24 in., the widest for which the side-dump cars could be built and allow the loaded car on the track to pass the empty on the siding.

At the beginning of operations, the locomotive hauled out 12 cars in a train, but as the length of the tunnel increased, it became necessary eventually to handle trains of 30 cars.

PIPE TRACK AND WIRING.

The ventilating pipe was carried on 4x6-in. vertical posts spaced 15 ft. It was kept close to the face and protected by a bulkhead of ties.

TABLE I. COMPARATIVE DATA FROM AMERICAN AND EUROPEAN RECORDS.

Name of Tunnel	Size in Ft.	Character of Rock	Progress for Entire Length: Average Monthly Advance in Ft.	Progress for Entire Length: During Months	Progress over Long Periods: Average Monthly Advance in Ft.	Progress over Long Periods: During Months	Best Monthly Record, in Ft.
Sheep Creek	8x10	Greenstone and slate	544.2	16	596	6	661
Loetschberg, Switzerland	6x10½	Limestone and gneiss	490	54	683	18	1013
Simplon, Switzerland	6½x9½	Schist	....	..	....	..	685
Arlberg, Switzerland	8½x9½	Gneiss	474	36	....	..	641
Tauern, Austria	....	....	....	..	525	11	548
Laramie-Poudre	7½x9½	Granite	473	19	525	12	653
Strawberry, Utah	9x11	Limestone	....	..	426	11	492
St. Louis Waterworks	10 ft. diam.	Limestone	430	5½	....	..	745
Arizona Copper Co.	8x8	Porphyry	....	..	669	3	799
Rawley, Colo	7x8	....	....	..	358	17.4	....
Mammoth, Calif	8½x9½	....	....	..	316	9½	395
Roosevelt, Colo	6x10	....	....	..	292	12	435
Mt. Royal, Montreal	8x12	Limestone	....	..	....	..	810
Gunnison	6x10½	Soft limestone	....	..	....	..	824
Los Angeles Aqueduct	12x13	Black shale	....	..	....	..	604
Los Angeles Aqueduct	12x13	Cemented sand	....	..	....	..	1061

A compressed-air line was carried along the bottom on 4x4-in. sills, which also supported the board walk; the end of this pipe was protected by the same bulkhead. The main line was always thus within a hose length of the face. An extra manifold was kept on hand and when it was necessary to extend the pipe line, this manifold was attached to the new length of pipe before the latter was put on; this considerably facilitated the operation.

The rails used were 50-lb. and were laid on 6x8-in. by 6-ft. ties. When the track is widened to its permanent gage of 36 in., one rail only will be moved.

Six wires were carried the length of the tunnel; three of these were used for the single-phase, 110-volt lighting system, the purpose of the third wire being to give equal voltage at all points in the tunnel. The other three wires constituted the three-phase, 440-volt alternating circuit for the ventilating-fan motors.

SPEED OF ADVANCE.

Drilling was started November, 1912, but the work was not considered as completely organized until December, 1912. Between December 1, 1912, and April 1, 1914, a period of 16 months, the tunnel was advanced 8,707 ft. with a single heading, an average of 544.2 ft. per month. During the last six months, the average monthly advance was 596 ft. The greatest monthly advance was 661 ft. made in November, 1913. At various times advances of 24 ft. per day were made. It is believed that this constitutes the world's record for sustained progress in extremely hard rock with an 8x10-ft. tunnel section. Monthly records have been made considerably in excess of 661 ft., but we know of no record equals that of 596 ft. maintained for six which equals the average advance of 544.2 ft. over the entire period of operation covering 16 months and of no American record which months. Tables I and II present data covering this point.

TABLE II. SHEEP CREEK AND LOETSCHBERG TUNNELS.

	Sheep Creek	Loetschberg	Ratio
Size of tunnel, ft.	8x10	6x10½	1.26 : 1
Area of cross-section, sq.ft.	80	63.5	1 : 1.53
Best monthly record, ft.	661	1013	1.1 : 1
Record on entire length, ft.	544.2	490	
Average progress per round, ft.	4	3.97	1.4 : 1
Average length holes, ft.	6.37	4.54	1.64 : 1
Number of holes per round	22	13.4	2.28 : 1
Total footage holes per round	140	61.3	1 : 2.53
Drilling time per round, hr.	1.58	4	1.1 : 1
Drilling time per ft. of hole, min.	1.72	1.55	1.18 : 1
Entire duration one round, hr.	5.3	4.48	
Strength of dynamite used	60%	85%	
Pounds used per ft. advance	34	15.5	
Number of drills used	4	4	
Support for drills	Horizontal bars	Carriage	

WAGES AND BONUS.

On account of the peculiar shift arrangement, the men were paid by the hour, and in addition a bonus was distributed. The wages were as at top of next column.

A bonus was paid as follows: For 300 ft. per month or under, no bonus; for 300 to 350 ft. per month, $7 per ft. for the 50 ft.; for 350 to 400 ft. per month, $8 per ft. for the

Machinemen, muckers and carmen	$0.50
Shift bosses	0.58
Blacksmith	0.60
Tool sharpeners	0.50
Tool-sharpener helpers	0.40
Blacksmith helpers	0.35
Compressor men	0.40
Electricians	0.50
Timekeepers	0.45
Carpenters	0.60

50 ft.; for 400 to 450 ft. per month, $9 per ft. for the 50 ft. This increased $1 per ft. for every additional 50 ft.

The foreman distributed the bonus according to his judgment. It was his practice to give the lower-bar machinemen $30 a month bonus, independent of the total amount received. The muckers, carmen and motormen each received $10 to $15 per month bonus at the foreman's discretion. The tool sharpeners received $45 per month bonus. The amounts noted above were deducted from the total bonus of any one month and the remainder divided equally among the top-bar machinemen and the shift bosses. His idea was to give the greatest reward and the greatest incentive to the men chiefly responsible for the rate of progress. The result was thoroughly satisfactory.

NECESSITY FOR HIGH SPEED.

The development of the Alaska Gastineau property involves the expenditure of an extremely large sum. It consists of several different elements, and economy requires that these be completed as nearly as possible at the same time. Driving the tunnel was the work which involved the greatest number of contingencies and unknown factors. It was, therefore, imperative that it be completed in time, and for this reason the high speed of driving was aimed at. More important, however, was the fact that by pushing the tunnel through rapidly, it became available for development work by raises which otherwise would have had to be done by sinking, and the raising cost is only about one-third of the sinking. The tunnel was also made available for handling a considerable amount of muck, 300 tons, which otherwise would have required hoisting to the Alexander level and dumping on a hillside where room was limited. There is no doubt but that the tunnel could have been driven more slowly at a lower cost per foot, but the indirect economies mentioned would not have been obtained.

COSTS.

The following cost data apply to the 8,707 ft. driven between Dec. 1, 1912, and April 1, 1914, this representing the distance driven under the standard conditions described:

Wages	$14.72
Bonus	4.14
Explosives	4.47
Lighting	0.28
Tool replacement	1.35
Lumber and miscellaneous supplies	0.75
Store expense and transportation	0.38
Power and compressed air	2.53
Loss on boarding house	1.17
Depreciation on mining tools	1.29
Total	$31.08

A $1 charge per man per day for board did not cover the cost, inasmuch as the food was of high class and expenses of transportation and help were excessive. Nearly all the men ate four meals per day. Under "power and compressed air" is included the operating expense of furnishing the compressed air and of ventilating. The labor of installing pipes is included, but not the cost of the pipes themselves, since this became permanent equipment.

It is believed that the excellent results obtained in driving this tunnel were due to the following factors: (1) The energy and skill of the foreman, P. H. O'Neill; (2) the bonus system; (3) efficient ventilation; (4) the elimination of switches in the tramming system; (5) the excellent equipment and the large supply of spare parts kept on hand.

DIVING SERVICE ON THE PANAMA CANAL

If a ship passing through the canal require the services of a diver such service is always ready. The rates quoted below are effective for the following services furnished individuals, companies, and others, according to an announcement by Gov. Goethals, of the Canal Zone:

For service of a diver, his assistants, and apparatus, for the first four hours or fraction thereof, from time of arrival at point of diving	$60.00
For each succeeding hour or fraction thereof	10.00
Compressed air, per 1,000 cubic feet	.12
For giving cable notice of deposits with the Treasurer or Assistant Treasurers of the United States to be applied in payment of tolls, material, supplies, and services	5.00

FREIGHT TUNNELS FOR NEW YORK

No man could have been suggested more fully qualified to discuss the harbor needs of New York, especially as to the reception, transmission and distribution of freight than Mr. T. P. Shonts, former Chairman of the Panama Canal Commission, and now President of the Interborough Metropolitan Company, and this he has done in a marvellously comprehensive way in a recent Sunday issue of the New York Times. He first discusses the inadequate and unsatisfactory "facilities" now existing. He says there are daily standing on the railroad tracks about New York from 4,000 to 6,000 cars, awaiting the opportunity to discharge their contents and return to normal trade channels. This means that an investment in cars alone of from $4,000,000 to $6,000,000 is lying idle, because the facilities of the Port of New York are inadequate even with the business at present being done, and the situation will not be relieved until ferries, car floats, and lighters shall be superseded by a continuous freight movement through river tunnels. The natural location for great railroad yards to handle, assemble, and classify all this traffic is the Hackensack Meadows in New Jersey.

IMPORT AND EXPORT TRAFFIC.

The matter of exchange of traffic between the railroads and the water carriers brings up the question of a great import and export depot at Bayonne, N. J. It has been estimated that the terminal cost of handling a ton of "all rail" or "water and rail" freight at the Port of New York is as much as to move the same ton 300 miles on any of our trunk lines of railway. The waters of New York Harbor, which are continuously becoming more and more congested, divide the port into five grand divisions—Manhattan, the Bronx, Long Island, Staten Island, and New Jersey. The water front of Bayonne is the economic and geographic location for an import and export harbor. Piers 4,000 feet long could be extended into New York Bay without interfering with navigation, into which cargoes could be unloaded from ships into storage and then to cars, and vice versa, with the minimum of handling. With Bayonne as the exclusive import and export harbor of the Port of New York, there would be saved on 80 per cent. of her import and export tonnage the cost of floatage, and the congestion of her waterborne traffic would be relieved to just that extent.

LOCAL FREIGHTING IN GREATER NEW YORK.

The tunnel is the solution of New York's freight distribution problem. Tunnels may be built one after another, as needed. They may be located between points as and where changing future requirements may demand. Besides creating the shortest and most economical route between New Jersey and New York, the desirability of minimizing the number and length of necessary rail movements in the freight subway in Manhattan must be kept in mind.

With a bridge, traffic would have to come across the river concentrated through one fixed channel, which would mean that for all time freight, after reaching Manhattan, would have to be handled either in the subway or by an elevated structure for the full distance from Fifty-seventh Street to a southern terminus—say Cortlandt Street.

The tunnel is an entirely different proposition, however. Should the future density of traffic coming into Manhattan warrant it, communication between the shores of the Hudson could be carried on through a "battery" of tunnels. The volume of business could be split up by having one tube connecting up on the Manhattan side, say at Canal Street, to serve the tonnage zone between Canal and Cortlandt Streets; another at Fourteenth Street, to serve the zone between that and Canal; another at Twenty-third Street, to serve the zone between that and Fourteenth Street; another at Thirty-third Street, to serve the zone between that and Twenty-third Street, and so on as the requirements of commerce demanded.

With a freight subway on the west side of Manhattan, served by tubes under the Hudson River, logical extensions could be carried across Manhattan Island to another freight subway on the east side of the city, to be constructed, link by link, as occasion required.

The next logical extension would be under the East River into the great manufacturing and commercial centres of Brooklyn and South Brooklyn, thereby, incidentally, making the shortest possible direct connection between the railroads of New Jersey and New England (by means of a comparatively short line to the Connecting Railroad, now in process of construction) and linking up the distributing ter-

minal facilities of the Port of New York into a honogeneous unit.

Upon the completion of the tunnels under the Hudson and across Manhattan into Long Island, the waters of the harbor would be relieved of the floating service now operated by the New Jersey railroads, and the water front given over almost entirely to modern piers for the exclusive accommodation of passenger steamers and the freight and express business they carry.

BRIDGE AND TUNNELS.

While the tunnel solves New York's freight-distribution problem, a bridge of suspension type over the Hudson is structurally feasible, and it is not improbable that at some future time both tunnels and a bridge will be necessary to meet the commercial requirements of New York—the bridge to form the connection with the great highways of vehicular and pedestrian travel of New Jersey, Manhattan Island, and Long Island, and the tunnels to accommodate the railway, freight, and passenger business, as well as heavy trucking traffic.

COMPARATIVE COSTS.

The greater expense of a bridge over that of a tunnel is a matter to be considered. The original estimate of the North River Bridge Company, which had a charter for a bridge opposite Twenty-third Street, but was compelled for reasons already mentioned to change its site to the neighborhood of Fifty-ninth Street, as to the cost of a structure of sufficient capacity to answer all purposes, including approaches, connections, and stations, complete, was between $90,000,000 and $100,000,000. More recent estimates made for a suspension bridge to meet all requirements including eight lines of rapid transit, two thirty-six feet wide driveways, and two eight-feet-wide sidewalks, place the cost at $42,000,000, as compared with an estimated cost of approximately $7,000,000 for a tunnel. That is, the cost of a bridge would be approximately equivalent to the cost of six tunnels.

Keeping in mind the fundamental thought that the railroads may be induced to pool their present properties, one is surprised, on studying a map of the port, to note how readily and at what relatively small expense existing railroad properties may be connected up; how short stretches of rail will unite the terminal lines in New Jersey with the great clearance yards to be established in the Hackensack Meadows; how another short stretch to Bayonne will link them up with the great import and export depot to be built there; how a tunnel or tunnels under the Hudson will connect with a subway up and down, say, Eleventh Avenue, and switches run to such piers as the traffic necessities of the city indicate ought to be reserved for each particular freight zone; how an extension of the subway across Manhattan to one alongside the East River, with switches to piers on that water frontage, will link up with a tunnel under the river to tap the nucleus of a series of belt lines to be extended indefinitely through Brooklyn and Queens—which two boroughs are the natural field for an unlimited development of the city's manufacturing industries for generations to come.

The above, we are well aware, is an entirely inadequate presentation of the valuable paper of Mr. Shonts, but it is all that our space will permit. The paper should be studied in its entirety by those interested.

OUR EXPORTS AND IMPORTS

The world's leading importers are the United Kingdom, Germany and the United States, in the order named, France being fourth and the Netherlands fifth. The United States and the United Kingdom are the world's largest exporters, followed by Germany, France and the Netherlands. The United States furnishes about 20 per cent. of the total imports into the United Kingdom, 15 per cent. of those into Germany, 10 per cent. into France, 14 per cent. into Italy, 65 per cent. into Canada, 53 per cent. into Cuba, 50 per cent. into Mexico, 15 per cent. into Argentina and 15 per cent. into Brazil.

The Commercial Relations of the United States, a volume of 272 pages, just issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce, contains revised figures showing in detail for the year 1912 compared with the previous year the articles entering into the trade of each country and the commercial transactions with the United States. This volume should prove valuable to those interested in the foreign trade of the United States and foreign countries. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 40 cents each.

GAS NOT EXPLOSIVE

The idea, still widely prevalent, that certain gases are explosive in themselves, is erroneous, as was proved in a very striking manner by Samuel Clegg at the installation of the first gas-house in London. To the consternation of the examining commission Clegg bored a hole in the wall of the gas-holder and ignited the issuing stream of gas. A long flame shot out, burned quietly, without the slightest explosion, until it was extinguished by the sinking of the gas-holder bringing the hole below the level of the surrounding water. When an attempt was made to blow up a Glasgow gas house with dynamite only the iron parts were shattered, and the escaping gas burned without explosion. In such cases the ignition of the escaping gas is a safeguard against explosion as it prevents the formation, in large quantities, of explosive mixtures of gas and air.

Even an explosive mixture can be prevented from exploding by the addition of an inert gas. This is of great practical importance because such an inert gas is available in large quantities in the carbon dioxide which constitutes from 8 to 14 per cent. of the chimney gas of steam boiler furnaces. Eitner and Trautwein have proved that any mixture of illuminating gas and air can be made inexplosive by the addition of 7½ per cent of carbon dioxide. This fact is utilized for the prevention of explosion due to the mingling of gas and air in the first filling of new gas holders and gas pipes. Furnace gas is blown through the system before the illuminating gas is admitted.

In even the most explosive mixtures explosion can be prevented by cooling below the temperature of ignition. A jet of such a mixture, issuing from a tube a diameter less than 1-12 inch, may be ignited without exploding the mixture inside the container, because of the cooling effect of the walls of the small tube. The construction of Davy's safety lamp for miners is based on this principle. The flame is inclosed in fine wire netting, which is equivalent to a multitude of small tubes. Fire damp (methane), if present in the air of the mine, enters the net and burns therein, without exploding the mixture of gas and air outside.

Some explosive mixtures of gases are usefully employed in heating by gas, in incandescent gas lighting, and in explosion motors. All gas heaters and incandescent burners operate on the principle of the Bunsen burner, which automatically mixes the illuminating or fuel gas, before combustion, with a quantity of air. In gas stoves this addition of air is made in order to produce a non-luminous flame, to prevent the blackening of objects exposed to the flame, and to assure complete and odorless combustion of the gas. These objects are the more perfectly attained the larger the proportion of air that is added to the gas. When illuminating gas at the usual pressure, however, is mixed with more than thrice its volume of air (a quantity insufficient for complete combustion) the velocity of efflux is less than the velocity of propagation of ignition, so that the flame "strikes back." The quantity of air added can be increased by increasing the pressure of the gas. This is especially advantageous in incandescent gas lighting where it is desirable to concentrate the combustion in a small space in order to produce a high temperature, and, consequently, an intense luminosity.

In explosion motors it is advantageous to use as little gas as possible, i. e., to approximate as closely as possible to the lower explosive limit. Richer mixtures (corresponding to the upper limit) cause violent explosions, which are far less completely utilized by the moving parts than the mild explosions and expansion produced by mixtures poor in gas. With some mixtures, especially hydrogen and air, these violent explosions may destroy the motor. The operation of explosion motors with very small quantities of gas or vapor is facilitated by the fact that the explosive range is considerably extended at the high temperatures and pressures that prevail in the interior of the cylinder. These principles have been utilized so fully in recent years that the motors of automobiles have attained a perfection that no one would have ventured to predict twenty years ago. This remarkable development is due to increased knowledge of the behavior of explosive mixtures of gas, and this knowledge has been acquired from practice, not from purely scientific researches. In this field practice is far ahead of pure science.

The railroad tunnel through the Cascade Mountains at the summit of Snoqualmie Pass, in Washington, 12,000 feet long, has been completed with the unusual and enviable record of "no lives lost."

PNEUMATIC CAISSON SCHEME FOR SUBAQUEOUS TUNNEL CONSTRUCTION

The difficulty and the cost of driving subaqueous tunnels through soft material by the now familiar shield method are sufficiently well known to engineers, special attention being directed to those which have been built and those which are to be built under the East River, New York city.

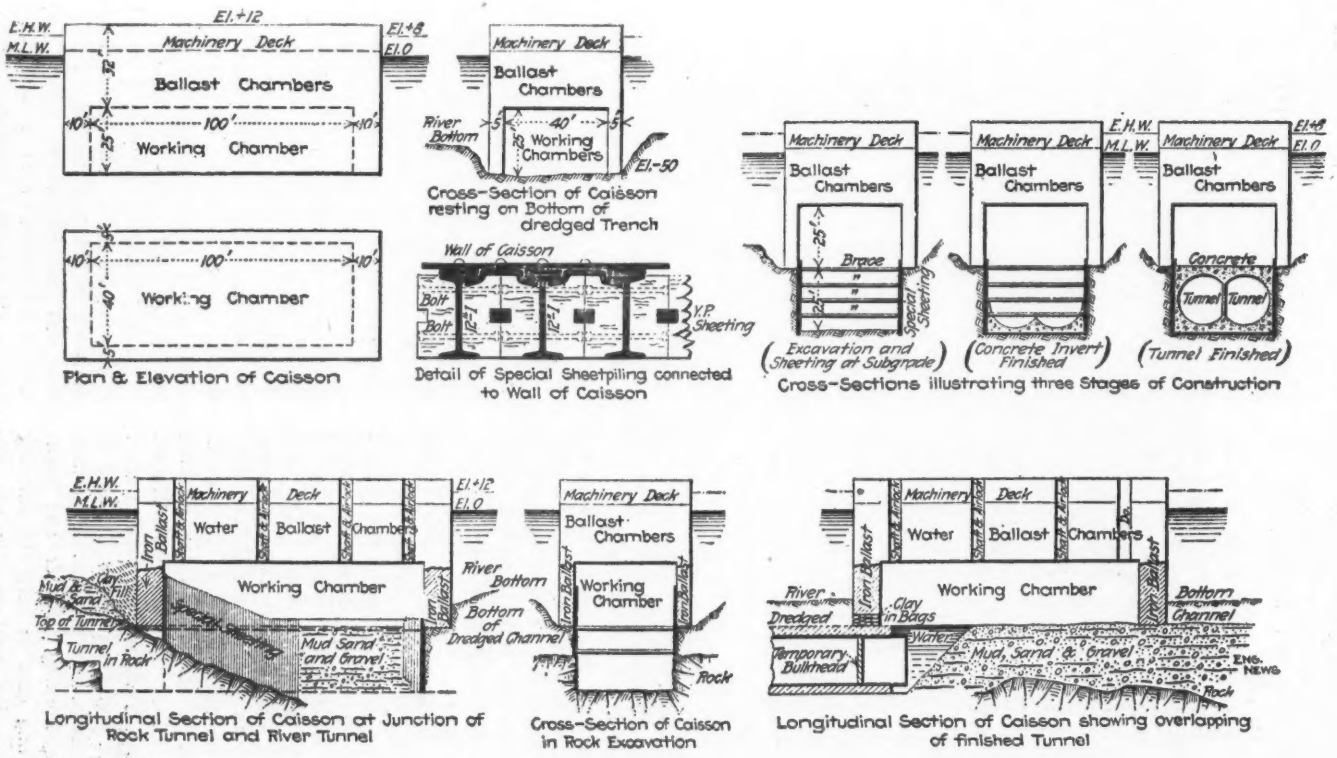
The fundamental cause of most of the troubles which have been experienced here is found in the difference in hydrostatic pressure at the bottom and at the top of a tunnel heading. Air pressure sufficient to keep the floor of a tunnel dry will be enough greater than the hydrostatic head at the roof of the tunnel to allow the air to escape in great volume; and when the cover is not sufficiently heavy, may even blow a hole through the river bottom and by thus suddenly reducing the air pressure in the tunnel allow the water and mud to enter the tunnel, resulting in a "blow-out." In practice this difference in pressure is kept as small as possible by keeping the air pressure in the tunnel about equal to the hydrostatic head at the middle of the tunnel section; but it is still greater than the hydrostatic pressure at the roof of the tunnel; and this difference in pressure is the chief cause of the delays and expense in building tunnels by the shield method.

An entirely different plan for tunnel construction under the conditions here encountered has been suggested by Mr. Emil Diebitsch, Vice-President of the John Peirce Company, 90 West Street, N. Y. City, who described his scheme in a comprehensive article in *Engineering News*, Oct. 22, 1914, what is here presented being an abstract of a small portion only of that article.

In the shield method the work of excavation and construction is carried forward in a vertical plane or heading under a condition of unbalanced pressures. In the method herein proposed the work is carried on in a horizontal plane under a condition of balanced pressures. The method in general consists of building successive lengths of the tunnel under the protection of a huge movable pneumatic caisson which rests on the river bottom and extends above the surface of the water like a dock or pier. When a section of the tunnel has been completed, the caisson is moved forward along the line of the proposed tunnel, so that another section of tunnel immediately adjoining the finished section and connecting with it may be constructed. By repetition of this process the entire tunnel between pierhead lines may be built.

This caisson is really a huge steel box with double walls inclosing ballast chambers, surrounding a working chamber decked over on top but open at the river bottom. Water is excluded from this working chamber by means of compressed air and access to it for men and materials is gained by means of shafts and air locks in the usual way. The word caisson is used to designate this steel box, but it should be noted that this structure differs in design and function from the caissons used for foundations of bridges and buildings. It does not permanently form the bottom of the finished structure as ordinary caissons do, but is used as a temporary protective covering placed over the portion of the tunnel under construction, and is moved to a new position as soon as the tunnel section is completed. This caisson rests on the river bottom above and at the edge of the excavation within which the tunnel is built. It therefore has no cutting edge but a broad base, giving ample bearing surface for stability and to prevent the caisson from sinking too deeply into the mud of the river bottom. To facilitate the handling of the caisson, it is provided with ballast chambers which can be readily filled or emptied of water by means of valves and pumps. These ballast chambers must be large enough to contain sufficient weight to hold the caisson securely on the river bottom when the tunnel construction is proceeding. Enough of the ballast should be water for easy handling, which, when pumped out of the chambers, will permit the caisson to float.

Reference to the accompanying drawings will show that the caisson under consideration has the following principal dimensions: Length 120 ft.; width 50 ft.; depth 62 ft. Length of working chamber 100 ft.; width 40 ft.; height 25 ft. The estimated weight without machinery or ballast is 2500 tons. This structure is large enough and strong enough to form when resting on the river bottom, a pier to which scows, lighters, tow boats, etc., may be moored and on which materials and supplies may be landed. The main deck of the caisson will be equipped with derricks, hoisting engines, concrete mixers and such other machines and appliances as may be needed for expeditiously



SKETCHES ILLUSTRATING A PROPOSED CAISSON METHOD FOR CONSTRUCTING SUBAQUEOUS TUNNELS

and economically handling the excavated materials from the working chamber to the scows and the structural materials such as sand, gravel, cement, steel and lumber from the lighters to the air locks.

The machinery deck, located about 12 ft. below the main deck, will contain boilers, air compressors, steam engines, electric generators, motors, pumps and such other machinery as may be needed in constructing the tunnel or handling the caisson. The walls of the working chamber are provided with interlocking tongued-and-grooved poling boards or shutters which resemble sheet piling. These sheet piles are shown in the drawing as constructed of steel I-beams with grooved timbers bolted on each side of the webs of the beams. These sheet piles are used as vertical poling boards and are carried down a little in advance of the general excavation and serve to keep the air within the excavation from escaping too freely. They also sustain the banks of the trench within which the tunnel is built. It should be noted that each sheet pile is attached to the wall of the working chamber by means of bent steel plates forming a groove within which the sheet pile can readily be moved vertically up or down but which resists lateral displacement of the sheet pile.

Having constructed the caisson as above described with all necessary men and material locks, ballast chambers, etc., and equipped it with air compressors, boilers, pumps, dynamos and other necessary machinery, the procedure is as follows:

A trench is dredged along the line of the proposed tunnel, wide enough to hold the caisson when resting on the bottom of the channel and at least 45 feet below extreme low water, as the harbor regulations require the top of the tunnel to be below that depth. The caisson is towed to a point selected for beginning work and sunk by flooding the ballast tanks until it rests on the bottom of the channel. Compressed air is forced into the working chamber until all of the water is excluded, some of the water being pumped out if deemed more expedient, and more ballast is added in order to hold the caisson in place. Workmen now enter the working chamber and begin excavating, taking care to keep the sheeting below the excavation, and cross bracing the sheeting if necessary, as the excavation proceeds. When the bottom of the excavation is reached, concrete is placed to form the foundation and invert for the tunnel lining.

The tunnel can now be built as designed—whether of massive or of reinforced concrete with waterproofing of fabric and pitch or asphalt or brick laid in asphalt. Should it be found desirable to surround the tunnel with a metal casing to act as waterproofing, this can be made of thin steel plates or of sheet copper. When a section of the tunnel has been completed, the sheet piling must be drawn and secured to the walls of the working chamber after which the caisson is to be moved ahead.

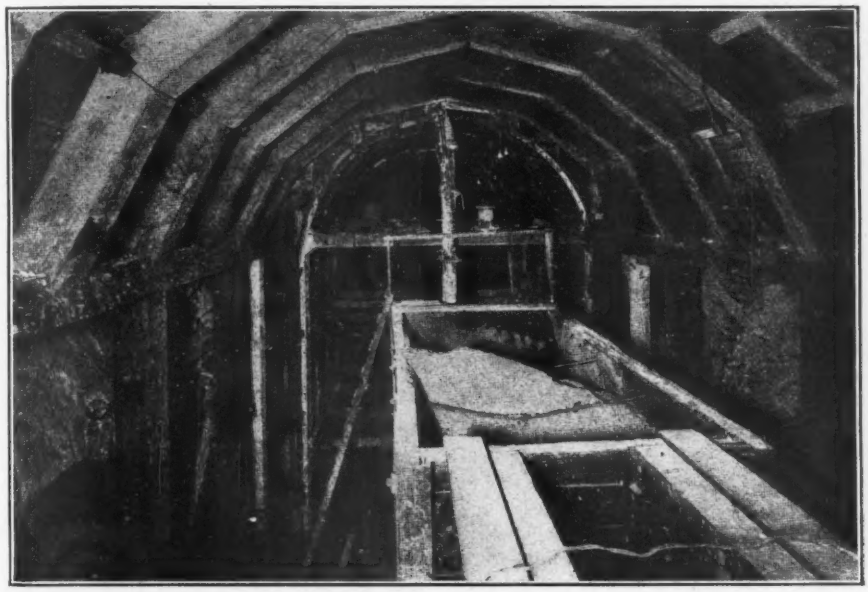
The next step is to float the caisson by discharging ballast and to move it along the line until the rear end just overlaps the finished portion of the tunnel, thus allowing the end of the finished section to project into the working chamber. The caisson must now be sunk to the bottom of the channel in this position by flooding the ballast chambers, after which the work now proceeds as before.

These operations would serve for constructing the portion of the tunnel under the river, but provision must be made for connecting the river tunnels with the tunnels on the Manhattan and Brooklyn shores. A study of the boring sheet made by the engineers of the Public Service Commission for the new subway tunnels from Whitehall St., Manhattan, to Montague St., Brooklyn, for which contracts were recently let, show that approaching the Manhattan shore the rock in the river apparently rises sufficiently above the top of the tunnel to permit of driving a tunnel in the rock in the ordinary way. In this case the caisson could be located near the point where the tunnel enters the rock from the sand and mud in the river and a heading could be started into the rock from the working chamber of the caisson. If the rock is of such a character as to require compressed air to keep the excavation dry, or compressed air and a shield, the air could be furnished from the plant on the caisson and the tunnel driven toward the shore, using the caisson as a shaft. If on the other hand the rock is solid and the tunnel can be driven without air, it might be advisable to bulkhead the tunnel after it has been well advanced into the rock and drive the rest of the tunnel under normal air pressure from a shaft on the Manhattan shore.

On the Brooklyn shore, where the tunnel enters earth and sand below mean high water,

it may be advisable to use a shield. The shield could be set up in the working chamber of the caisson and operated with the plant on the caisson, using the caisson as a shaft for men and materials.

the safety of the men erecting the forms. To protect the men further, planks are laid from the remaining timbers to the concrete to catch any small pieces of rock or give warning in case a large rock should fall. From 5 to 20



DEPOSITING THE CONCRETE.

COMPRESSED AIR FOR LINING A TUNNEL

Compressed air is being used in lining the 800-ft. summit tunnel between Casper and Thermopolis, Wyo., on the new line of the Chicago, Burlington & Quincy Railroad connecting Thermopolis and Orin Junction. The tunnel was excavated a year ago in rather treacherous sandstone, which required timbering throughout its length. It is now being lined with concrete and the timber is being removed as the concrete lining is placed. Material for the concrete is brought in gondola cars from Casper, where the sand and gravel are dredged from the river.

Three operations constitute the work of lining the tunnel; these are first, the removal of timbers; second, the erection of the Blaw steel forms, and third, the mixing and placing of the concrete. The timbers are pulled down by a dinkey engine, cables fastened to the bottoms of the uprights passing through snatch blocks placed in the center of the track. When the posts are pulled out the debris is cleared away and the loose rock is picked down to insure

ft. of timber, depending on the condition of the rock, are removed at one time.

Erection of the forms consists of placing a steel channel rib, which fits the section of the tunnel, and connecting it with the last rib previously placed by means of steel plates 4 ft. long and 3 ft. high. These plates are built up solid to the top of the arch, as the concrete placed by the compressed-air method, allows the forms to be built complete before concreting begins. The steel ribs of the forms are 4 ft. apart, corresponding to the length of the plates, and from one to five sections are set up at a time, according to the length of timber removed.

THE OUTFIT.

The mixing and placing outfit consists of a pneumatic concrete mixer and conveyor mounted on a 40-ft. flat car, equipped with bins holding 26 cu. yd. of material. The cement is stored in bags under one of the bins and discharged toward the center of the car through chutes into a measuring hopper. This measuring hopper is lifted and tilted automat-

ically to discharge into the mixer. The lifting device is a 6-in. air cylinder. The 8-in. delivery pipe leads from the mixer under the car and vertically up at the end of the crown of the arch, where a 90-deg. elbow enters through the bulkhead of the form. Air is supplied from a compressor at the mouth of the tunnel through a 4-in. main laid on brackets fastened to the timber posts, and a connection is afforded from the main to the air receiver on the car by means of a hose.

The proper size of compressor to run a portable outfit of this kind is believed to be about 300 cu. ft. capacity of free air per minute, compressed to from 80 to 100 lb. In beginning the work, however, a compressor of 134 cu. ft. nominal capacity was furnished by the railroad from one of its yards. The amount of air actually furnished by the compressor was approximately 80 cu. ft. per minute. This is thought to have reduced the output of the mixer and conveyor, and is mentioned because it applies to the data given below.

OPERATION.

The car is taken into the tunnel by means of the dinkey engine and spotted at a point next to the forms. The upper elbow of the delivery pipe is previously suspended in place so that when the car is "spotted" the upper pipe is bolted to the pipe on the car, which comes directly under it. The air connection is then made and concreting immediately begins.

The car is loaded by means of a portable derrick, which handles a wooden skip, as a clamshell bucket was not at first available. This wooden skip is loaded by several men shoveling the bank-run gravel into it, and is then lifted above the bins on the car and dumped into them.

The first work done by the outfit, which embraced the lining of the first 20 ft. of forms required five carloads of concrete material to fill the form. The entire work of tearing down timbers required 128 men-hours, the total time erecting forms was 229 1-2 men-hours, the time loading gravel and cement on the car required 140 men-hours and the total time required for mixing and placing the concrete in the forms was 204 men-hours. The total yardage placed was 132 cu. yd. From these figures it is seen that the number of men-hours required for the various items per cubic yard of concrete was as follows:

Item.	Men-hours per cu. yard.
Tearing down and cleaning timbers....	0.97
Erecting forms	1.74
Mixing and placing concrete.....	1.50
Loading gravel and cement.....	1.06

The substitution of a clamshell bucket when available is expected to cut the cost of loading the car to about ⅓ men-hour, or say 10 cents per cubic yard, and the substitution of a 300-cu. ft. compressor will, it is thought, make it possible to mix and place one batch per minute. The number of batches on the car varies between 112 and 118. The time required at present to unload one car, including time of transporting and of connecting and disconnecting the pipe, is from 3½ to 4 hr.

The concrete mixer and conveyer used for the work was furnished and the portable outfit was designed by the Concrete Mixing & Placing Company, of Chicago.—*Eng. Record* (abstract).

TO KEEP DRILLS RUNNING

Under existing conditions it is found that the actual drilling time for machines on the Rand is less than five hours per day, and as men are paid for an eight hours' day it is apparent that the time wasted in cleaning down and rigging up the machines constitutes a serious loss to the industry. To meet this wastage and at the same time to obtain more holes per machine shift the Modderfontein "B" has, recently, inaugurated a totally new departure, under which expert stope timbermen with blasting certificates are instructed to go underground some hours before the drilling shift, and after making the stopes safe and cleaning down the faces, to rig up the machines ready for an immediate start when the shift comes down. In some cases the stopes will be attended to in a similar manner by the regular night-shift lashing gang where only day drilling shifts are engaged. "With the high wages paid to machine men," says Col. Bottomley, in his last annual report, "I see no reason why even the blasting should not be done by a special gang, thus leaving the drillers to devote a full eight hours to their work. The reduction in working costs under these conditions would be very considerable, and would probably in the end lead to the abolition of contract stoping."—*South African Mining Journal.*

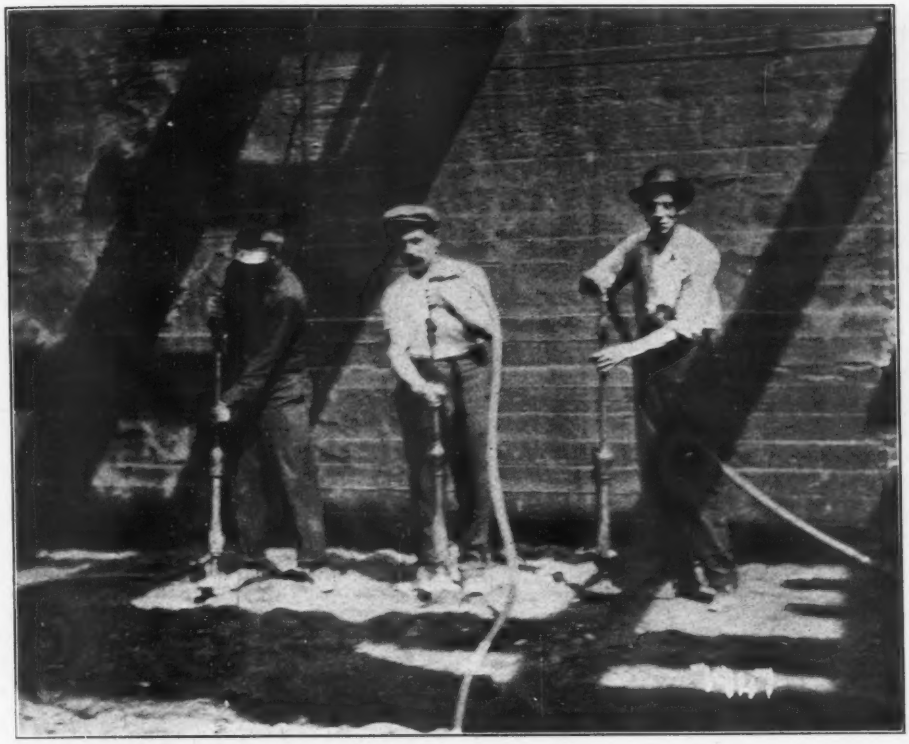


FIG. I.

PNEUMATIC TAMPERS ON HELL GATE BRIDGE VIADUCT

One of the many notable engineering works which in these later days seems to be always in progress within the limits of Greater New York, and which each involve some special and more or less novel details of design and construction, is the Hell Gate bridge of the New York Connecting R. R. Co. This will be perhaps the most notable and imposing of all the great bridges of the city, and strikingly different from all the others. It will be a heavy, single span, four track railroad bridge at a great height above the water so that navigation will not be interfered with, which requirement must be observed during the entire operation of erecting the structure. The great height of the roadway of the bridge makes the construction of the approaches to it a vast problem in itself, and as these must be used for the conveyance and placing of all the material of the bridge span their early completion is imperative.

From the bridge level down to a height of 70 feet a steel viaduct supported upon equally spaced concrete piers is employed, but for the remaining descent down to 30 feet, about three-quarters of a mile, there are retaining walls with earth filling, an apparently simple arrangement but involving several novel features in the construction. The inner faces of the thin reinforced concrete walls are 57 ft. 6-in. apart. The walls are 3 ft. thick at the top with stepped footings 6 ft. wide at the base. They are connected by tie rods spaced 10 ft. apart, both horizontally and vertically. Stubs for these rods were built into the walls and the connections were made by turnbuckles. Timber trusses extend from wall to wall to carry the four temporary tracks for the working trains. When the filling is brought up to grade the switch tracks and truss caps are removed and the remainder of the truss is left buried in the fill.

The space to be filled is divided into sections by transverse bulkheads and by walls and arches when streets are cut through. There are five trains employed, each comprising 11 dumping cars of about 4 cu. yd. capacity each and an 11 ton dinkey engine, from 250 to 300 cars being handled per day, and the total fill

requiring 200,000 cu. yds. The material, which is a mixture of sand, gravel and loam is brought about 3 1-2 miles. The space to be filled is divided into sections by transverse abutments and by walls and arches where streets are cut through, and these sections are filled separately. The filling as dumped from the cars falls in four longitudinal winrows and these are spread into layers about 12 inches thick which are then tamped hard by the use of "Crown" pneumatic sand rammers, such as are used in foundries, in street paving operations and elsewhere.

Air for the tampers is supplied by an Ingersoll Rand compressor, belt driven from a 150 h. p. electric motor, with a free air capacity of 946 cu. ft. per minute. delivered at 100 lb. gage. There is a 3 in. air line 1,400 ft. to the East River and another line of 2,100 feet in the opposite direction, both lines reduced for part of the distance to 2 in. with a 10 part manifold for 1 in. hose in sections where the tampers are at work.

When the tamping is brought up to the tie rods the operation is suspended while the rods are encased in concrete. Wood forms are placed around them and are filled with 1:6 concrete, which is permitted to set for 24 to 48 hours, according to the weather. Fig. 1 shows three of the tampers in position for work. In Fig 2, they are backed by one of the ribs or buttresses for a street wall.

An additional feature of the work is the rubble chimney construction which rises from weep-holes in the lower part of the viaduct for draining the bays. This chimney construction is shown in Fig. 3.

For the entire operation quite a number of men are employed. The steam shovel gang for loading the trains comprises an engineer, fireman and craneman, and there are six men in the pit gang. There is an engineer and a brakeman on each of the five trains, five laborers and a foreman attend to the dumping and in the bays there are 45 laborers, 2 foremen and 6 tampers. Of the latter sometimes 10 are at work at once, with an equal number of the pneumatic rammers always ready for service. These latter can be oiled and looked after while the others are in use, two machinists being employed for this and to attend to the piping. The concreting of the tie rods is done by 12 laborers and a foreman. The fill has proceeded at the rate of 2 ft. vertical per day.

The work is being done for the New York Connecting Railway, of which G. Lindenthal is Consulting and Chief Engineer, by Holbrook, Cabot & Rollins, New York City. The work is under the direction of T. B. Bryson for the contractor and Wyllys Russell is Superintendent at the site.

FIG. 2.

FIRST AID FOR GAS ASPHYXIATION OR ELECTRIC SHOCK

In line with its campaign to reduce the number of deaths in the mines of the United States, the Federal Bureau of Mines some time ago appointed a committee of eminent physicians and surgeons to develop an efficient method of resuscitation to be administered by miners or other persons to a fellow-workman overcome by electric shock or by gases in places which cannot be reached by a physician or surgeon in time to save life.

As a result of this committee's report just made, the Bureau of Mines, through Director Joseph A. Holmes, recommends the following procedure in rendering first aid to those in need of artificial respiration.

The recommendations apply not only to men who are overcome by electric shock or gases

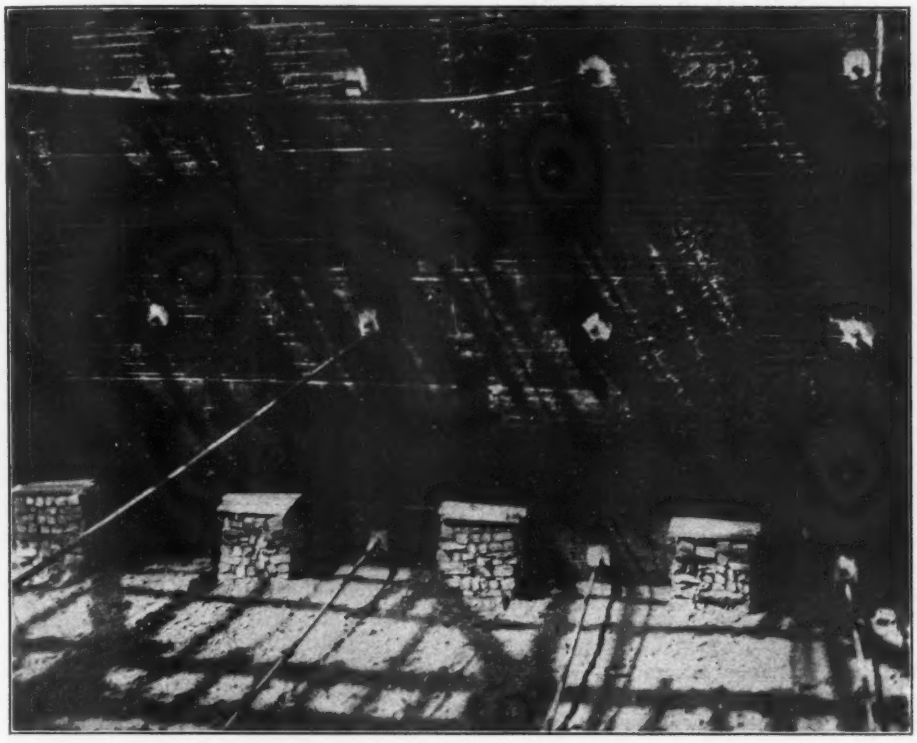


FIG. 3.

in mines, but also to persons suffering from the effects of illuminating-gas poisoning or from electric shock anywhere. The recommendations are, therefore, of importance to many thousands of workmen:

In case of gas poisoning, remove victim at once from the gaseous atmosphere. Carry him quickly to fresh air and immediately give manual artificial respiration. Do not stop to loosen clothing. Every moment of delay is serious.

In case of electric shock, break electric current instantly. Free the patient from the current with a single quick motion, using any dry non-conductor, such as clothing, rope, or board, to move patient or wire. Beware of using any metal or moist material. Meantime have every effort made to shut off current.

Attend instantly to the victim's breathing. If the victim is not breathing, he should be given manual artificial respiration at once. If the patient is breathing slowly and regularly do not give artificial respiration, but let nature restore breathing unaided.

In gas cases, give oxygen. If the patient has been a victim of gas, give him pure oxygen, with manual artificial respiration. The oxygen may be given through a breathing bag from a cylinder having a reducing valve, with connecting tubes and face mask, and with an inspiratory and an expiratory valve, of which the latter communicates directly with the atmosphere.

No mechanical artificial resuscitating device should be used unless one operated by hand that has no suction effect on the lungs. Use the Schaefer or prone pressure method of artificial respiration. Begin at once. A moment's delay is serious. Continue the artificial respiration. If necessary, continue two hours or longer without interruption until natural breathing is restored. If natural breathing stops after being restored, use artificial respiration again.

Do not give the patient any liquid, until he is fully conscious. Give him fresh air, but keep his body warm. Send for the nearest doctor as soon as accident is discovered.

EXPLOSIBILITY OF GRAIN DUST*

As a result of a number of explosions in grain mills and industrial plants in this country and in Europe, and more especially in view of an explosion in a feed grinding plant at Buffalo, N. Y., in June, 1913, by which 33 men lost their lives and upwards of 70 were injured, a co-operative movement between milling interests and the Bureau of Mines was arranged for the purpose of making a scientific study of the explosibility of grain dusts mixed with air, and of methods pertaining to the prevention of such explosives.

The work was started August 1, 1913, and during the preliminary study 13 explosions were investigated which occurred since 1905. These explosions were classified as follows: Cereal mills, 4; elevators, 3; feed mills, 2; starch factories, 2; glucose factory, 1; flour mill, 1. In these explosions 78 were killed, 119 were injured, and the damage to property exceeded $2,000,000.

Since 1911 four explosions have gone upon record in Europe, two in dextrine works, one in a provender mill grinding peas, beans and wheat, and one in a linseed mill, killing 47 and injuring 119.

Samples of the following dusts were collected and the conditions of their production were studied:

Dusts produced in the processes of elevating and handling grain, elevator dusts. Wheat flour dusts from rolls, bolters, purifiers, conveyors, packing machines, etc. Wheat flour dusts from beams, rafters, elevator heads, etc. Dusts produced in the cleaning of oats. Dusts from grinding white corn, yellow corn, oat hulls. Oatmeal dust from packing machines. Floor dusts from elevator sweeping. Oat groat dusts after aspiration.

These dusts were first analyzed in the U. S. Food and Drug Laboratory, Chicago. Experiments were then started in the Bureau of Mines at Pittsburgh to determine the ignition temperature of these dusts, using the method described by R. V. Wheeler in his report on the inflammability and capacity for transmitting explosions of carbonaceous dust liable to be generated on premises, under the Factory and Workshop Acts, 1913.

This method consisted in forcing the dust in a cloud through a glass tube, 3 inches in diameter and 55 inches long, against a heated platinum coil 15.75 inches from one end of the tube. The temperature of the coil was obtained by a Pt-PtRh thermopyle having its hot junction within the quartz tube upon which the coil was wound. Using this method, Wheeler determined the ignition temperature—temperature of propagation—of many dusts, obtaining results varying from 805 deg. C. for sugar, 960-1,035 deg, for starch, 990 deg. for oat husks, 995 deg. for grain (flour-mill) to 1,060 deg. for flour and 1,100 deg. for castor-oil meal. The results obtained upon grain dusts by the authors varied from 995 deg. C. for oat and corn elevator dusts, 1,015 deg. for feed dust from dust collector, 1,020 deg. for ground oat hulls, 1,025 deg. for yellow-corn dust, to 1,115 deg. for wheat elevator dust and 1,235-1,270 deg. for flour dusts. Wheeler worked with samples which had been dried at 107 deg. C., while the authors used the samples as received from the mill.

While the work gave the relative ignition temperatures it did not give the lowest temperature of ignition or the relative inflammability. This latter was determined by means of an apparatus developed in the Bureau of Mines. It consists of an explosion flask of about 1,400 cubic centimeters (85.36 cubic inches) capacity having two tubulures, a platinum coil, a device for driving a dust cloud against the coil and a Crosby pressure gauge for measuring the pressure developed. In each determination 50 milligrams (.00176 oz.) of the dust is forced in a cloud against the coil, which has been previously heated to a known temperature determined by a thermo-couple. The temperature is that inside the coil, and therefore higher than the actual temperature on the outside of the coil. The dust is ignited by the heated coil and a pressure developed within the flask, which is registered by the gauge. The relative inflammability at any temperature is measured by the difference in the pressures developed within the flask.

Determinations were made of pressures developed by the different dusts, as received and dried at 105 deg. C., when they were forced against the coil heated to 1,200 deg., 1,100 deg., 1,000 deg. and 900 deg. C. As no standard has been taken for carbonaceous dusts other than coal dust, Pittsburgh standard coal dust which

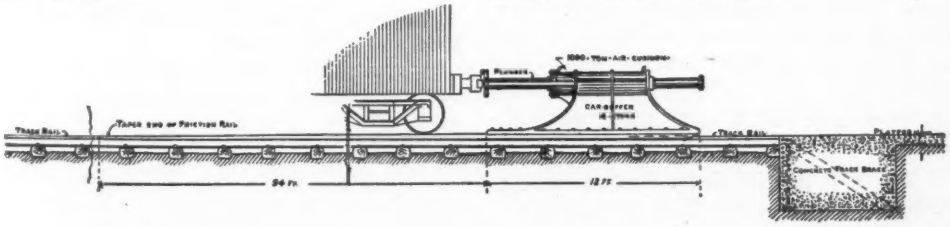
*Abstract of Preliminary Report by David J. Price and Harold H. Brown, Millers' Committee, Buffalo, N. Y.

is very constant in its properties and which is used as a standard in the Bureau of Mines was taken as such and all determinations were run against it and checked against each temperature.

Results indicate that most, if not all, grain dusts are more inflammable than Pittsburgh standard coal dust, higher pressures being developed in most cases and especially so at the lower temperatures. The results also seem to indicate that the dusts from oats and yellow corn are more inflammable than those from wheat or other grain. However, the results are only very preliminary, and it is possible that later work will change this supposition, and probably will change the curves plotted from the results, extending them to still lower temperatures.

It is interesting to note the difference in the inflammability of the dried and undried dusts. In nearly every case the pressure developed was appreciably increased after drying. Three cases are especially noticeable. These gave 0.5 pound pressure or less at 1,200 deg. when undried and over 8.0 pounds when dried, Pittsburgh standard coal dust giving 9.0 pounds at the same temperature. This is an indication of what may be expected when the humidity of the air is decreased.

Experiments carried out by the Bureau of Mines have shown that an explosion could be produced when there was only .032 ounce of coal dust suspended in each cubic foot of air or 1 pound in 500 cubic feet of air. In the experiments of M. J. Taffanel at the Lievin experiment station in France as low a weight as .023 ounce of coal dust per cubic foot of space was in one instance sufficient to produce an ignition.



SLIDING CAR BUFFER

Once in a while, owing either to miscalculation upon the part of the engineer or failure of the air-brakes, a train enters a terminal station with such velocity that it cannot be stopped before reaching the end of the track. To bring the train to a halt when it is not under proper control, buffers of various designs have been used, but it is no simple matter to design a bumper that will stop a train without, on the one hand, doing harm to the train, or, on the other, being seriously damaged itself. Recently a car buffer has been invented which is not rigidly secured to the end of the rails, but is designed to slide upon the rail when the momentum of the train is greater than a certain predetermined amount. This buffer is formed with two long shoes or tapered friction rails that rest upon the track. The train rides up on these shoes, and if not stopped in time strikes a plunger projecting from a pneumatic cylinder. The air cushion back of the plunger serves to retard the motion of the train; but if it is unable to stop it, the whole buffer slides along on the rail, until the section between the buffer and the rail is sufficient to overcome the momentum of the train. In a recent test of this buffer, it was found that a 1,000-ton train traveling at three miles per hour was brought to a stop without sliding the buffer. At four miles per hour, the buffer slid 9 inches. At 8 miles per hour the displacement of the buffer was 3 feet; at 16 miles, 12 feet; and at 32 miles, 40 feet. Of course it is seldom that a buffer is called upon to stop a train traveling more than three or four miles per hour. After the rails have been displaced over 12 feet the rate of friction runs up extremely high and overcomes the momentum with greater relative ease. Because the buffer yields before the impact more or less in proportion to the speed of the train, no damage is done and the train is halted in the shortest distance compatible with safety.—*Scientific American.*

Announcement is made that the Jersey Central is to build a new line under the name of the Eastern & Western, by which certain manufacturing establishments in the neighborhood of Easton, Pa., will be reached. The amount of construction involved is about four miles.

MINE REGULATIONS CONCERNING EXPLOSIVES

The following suggestions were sent to Coal Age by a mine foreman of long experience.

VENTILATION.

1. Have exhaust system of ventilation.
2. Use explosion doors on fan.
3. Current must be neither too strong nor too weak.
4. Use 4- to 6-entry system, work in panels, keep air courses clear of obstruction.
5. Use overcasts instead of doors; if doors, use automatic.
6. Have stoppings substantially built of masonry and kept in good repair, check doors at necessary intervals so that ventilation reaches the face of workings.
7. Use separate splits freely, have all abandoned workings thoroughly ventilated.
8. Have ample ventilation exceed the requirements of the law if necessary.
9. Install duplicate fans and engines so that they can both be used together if necessary.
10. In all narrow work crosscuts should be driven at least every 100 ft., if driven every 200 ft., the limit, and canvas is blown down it will accumulate a dangerous body of gas.

SHOT FIRING.

1. Employ skilled shotfirers acquainted with the extreme danger of gas and dust.
2. Use permissible explosives, copper bar and needle and clay tamping, fire one hole at a time with a battery when all men are out of the mine, commencing to fire shots, advancing against the air.
3. Do not shoot off the solid or holes drilled beyond the undercutting, shoot center hole first. If coal is 5½ ft. high and place 10 ft. wide shear one side or shoot in two layers.
4. Do not overcharge shots or use mixed explosives.
5. Holes must not exceed two inches in diameter.
6. Carefully inspect places for gas before shooting and after for fire, bad roof and gas.
7. Wet sides, roof and bottom for 80 ft. back before shooting.

DUST.

1. Use sprays to wet the coal in the cars and spray empty cars outside or at the shaft bottom.
2. Keep rooms and haulage ways clear of dust by loading it out, keep coal below beds of cars.
3. Use water or exhaust steam for moistening dust.
4. Before shooting, wet sides, roof and bottom for distance of 80 ft.
5. Use tight wood or steel cars to prevent leakage of coal and clean it up regularly before it is ground into powder.
6. Dust is dangerous, because when acted upon by a flame, it generates carbon monoxide, it absorbs oxygen out of the air.

GAS.

1. Do not allow mixed lights in a mine generating explosive gas.
2. Examine all places regularly and thoroughly for gas.
3. Do not allow accumulation of gas in worked-out portions of mine.
4. Consult the barometer for changes in the weather.
5. Employ competent and trustworthy firebosses and assistants.
6. Drawing stumps and pillars, take the coal out clean so roof can cave.

MISCELLANEOUS.

1. Have good discipline in the mine.
2. Systematic timbering of working places to suit conditions.
3. Mine foremen, assistant mine foremen and fire-bosses must all be sober, competent and respected men and see that they observe fully the requirements of the mining law.
4. Have danger signals printed in all languages spoken at the mine.
5. Have accurate surveys made of the worked-out or abandoned sections of mine.
6. Instruct all classes in the danger of mining.
7. At least instruct all company men in First Aid and use of helmets.
8. Prohibit electricity in a gaseous mine and carefully guard its use in a nongaseous mine.
9. Use stone dust to deaden coal dust explosibility.
10. Work all rooms on retreating system.
11. Prohibit the breaking of large pieces of rock by dynamite on top of them, do not allow shots to be fired in air courses, headings and traveling ways unless wires are properly guarded, men warned and dust wetted.
12. In gaseous mines work rooms from one side only.
13. Shear and undercut coal properly before shooting.

COMPRESSED AIR MAGAZINE.

EVERYTHING PNEUMATIC

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OUR NINETEENTH VOLUME

Our present issue completes the nineteenth year of publication of COMPRESSED AIR MAGAZINE, and the table of contents for the assembled volume will be ready to go out with the January number.

In looking over the volume as a whole and comparing its contents and make-up with those of the earlier years the advanced scope and status and the extended reach and employment of compressed air are strikingly apparent. Compressed air asserts itself in all the industries and no great undertakings are carried to successful completion without its aid. So many workers are now in touch with compressed air, so many think compressed air when they have anything to do, and they contrive so many new ways of using it and so many varieties of novel apparatus that it is no longer possible, even if it were necessary or desirable to speak of these in detail. And so, curiously enough, it is on account of the multitude of novelties that they do not appear so continuously on our pages as in the earlier volumes. Things are so numerous, and their individual novelty is so subdivided, and besides this, so many now know so much about these things that what once would have been welcomed as news is now already sufficiently well known without formal publicity.

As suggestive of the growth and extension of pneumatic interests it may be noted that our monthly lists of patents issued contain double the numbers recorded on our pages a dozen years ago, and, besides that, in our later selections we omit certain classes of patents, such, for instance, as those relating to pneumatic tires, wind power, aviation, etc.; yet still the variety of inventions reported as possessing some pneumatic feature or interest is continually astonishing, and it would be impossible generally to report and describe them more in detail.

With the limited space at our disposal it has seemed better to deal with pneumatic concerns in a large way and to present such matter as will appeal to the greater number of our readers. It frequently happens that the make-up of one of our issues has one preponderating topic, and by this fortuitous grouping of articles more or less related concentrates the interest. For instance the present might be called a tunnel number, and certainly it deals with perhaps the most important of compressed air activities.

The first article might be challenged as not a compressed air article at all, as only pick and shovel seem to have been the tools of the German soldiers, but the tunnel certainly was indebted to compressed air for its building in the first place, and the relation could not be forgotten. The story of the Sheep's Creek Tunnel, which, let us not forget, is in Alaska, is up to date in every particular, and is to be regarded with satisfaction by all concerned.

The scheme for building East River or other tunnels by the use of movable caissons above them, instead of by shields within, may be said to be perhaps rather more than up to date, but it is not difficult for us to believe that it heralds another compressed air triumph in the not distant future.

Another scheme promising certain ultimate fulfillment is that for the labyrinth of tunnels to be built for freight distribution in New York. The story of their construction may be expected to figure as a "to be continued" intermittant serial in future volumes of COMPRESSED AIR MAGAZINE.

In our present issue also attention is called to the Baltimore tunnel which paid for its construction, as we might say, on the spot. Tunnels have quite a habit of paying for themselves, directly or indirectly, and the building of them may be expected to go on continually at a not diminishing rate. Most of them will have some special features of design, or will develop incidents of interest in their construction which it will come in our way to tell about, and the vast field of other compressed air employments besides tunneling will be attended to as they come along.

JOINT CONFERENCE ON AVIATION

The Aëronautical Society of America, in collaboration with many national engineering organizations in this country, will on February 5 and 6, 1915, consider the inventions tending to increase the stability and safety of flight in heavier-than-air machines.

All inventors wishing to submit their inventions are invited to communicate with the Technical Board of the Society, 29 West 39th street, New York City, and submit to it all the data in their possession, such as patents, descriptions, data of tests, etc. If the inventor is in a position to submit a model or can show an apparatus of working size, he should so state to the Technical Board. It must be clearly understood that all information so submitted may be presented in public meeting of the Society, and, therefore, no inventions or data of a secret nature should be communicated to the Technical Board.

In addition to the Technical Board and the representatives of the Aëronautical Society of America, representatives of several national engineering organizations will take part. The following have already sent in lists of their representatives: The American Society of Mechanical Engineers, The American Mathematical Society, The American Physical Society and The Massachusetts Institute of Technology.

FANS FIGHT FIRE

In Boston not long ago, a fire broke out in the basement of a building occupied by a wholesale paint and chemical concern. The fumes and smoke became so thick it was impossible for the firemen to enter the basement or direct a stream with any effectiveness, when someone thought of electric fans. A half dozen of the ordinary 16-inch size were quickly requisitioned by the fire chief and their breeze was directed down the stairway. As soon as the rear basement windows were broken to allow the escape of the smoke and fumes, the effect of the fans gradually cleared the basement so that the firemen could work quickly and effectively in extinguishing the flames.

POWER RECOVERED

At a mine in South Africa the water supply has to be drawn from a considerable distance, and must, on its way, cross a ridge some 600-feet high. The water arriving at the mine is thus under considerable head, and power is recovered from it by means of Pelton wheels driving dynamos. In this way from 90 to 160 horse-power is gained, according to the volume of water flowing, and is utilized for various purposes at the mine. At another mine the cars conveying the ore run down an incline a vertical distance of about 250 feet. From the 2,200 tons of ore daily mined some 50 horse-power of electrical energy is here recovered by winding the cable of each car around a drum which actuates a dynamo.

TAYLORISM AND THE BONUS SYSTEM

BY FRANK RICHARDS

I am glad to note that the industrial journals, which have done so much for the promotion of the efficiency of machine tools and of manipulative processes, are now disposed to turn their attention to the worker himself, upon whom the ultimate success of all methods must depend. Just now the American industrial fad—and it is practically confined to America and must have its run here as other American fads do—is scientific management. The beginning of the so-called scientific management, which is still much more written about than practiced, is Taylorism, which has been spoken of in *The Engineer*, London, as "a peculiarly hideous method of dehumanization," a characterization which I think fits it well. Far from having the ultimate effect of promoting industrial conditions in the interest of either employer or employe, it deliberately brings about the degradation and belittlement of the individual American workman, it is inimical to the development of skill and paralyzes all incentive.

It is fortunate, or otherwise, for the system that it has had many and zealous advocates whom Mr. Taylor has hypnotized—I use the word deliberately—who have written voluminously concerning the workings of the system, and have spread their own stories as to what has been accomplished under it, while few or none have had the time or the interest to put forth their views and experiences in opposition, so that Taylorism and so-called scientific management stand before the public almost entirely upon *ex parte* testimony, and it would seem that any honest statements of opposing views should not be too hastily squelched.

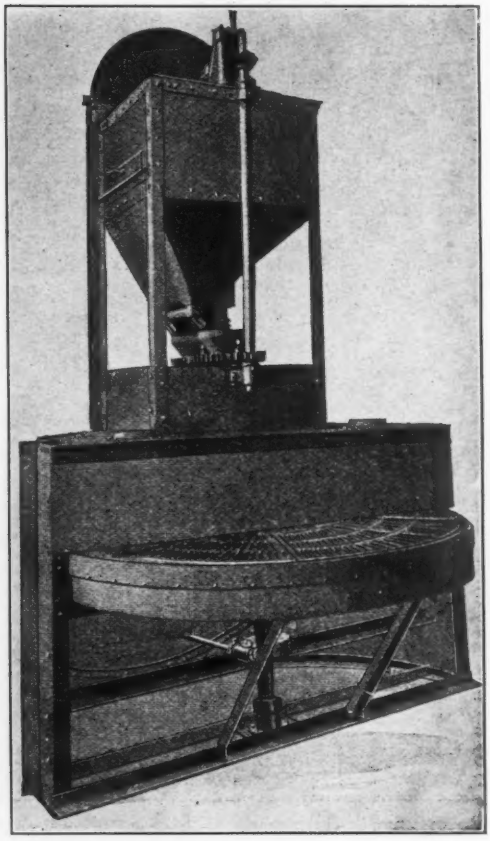
Speaking now a little more precisely: Under the Taylor system the doing of all work is to be planned in detail for the workman, and every move he is to make in doing a certain job is prescribed for him, with or without the time in seconds for each motion. This schedule is to be followed absolutely. Mr. Taylor has said before the American Society of Mechanical Engineers that the workman should be required to do his work so exactly as prescribed, that if at any time he saw a quicker or a better way of doing the work, that way must be ignored. I do not know that Mr. Taylor has ever said that the less a man knows about his work the better, but the man who knows nothing at all would seem to be his ideal workman. What incentive could there be under the Taylor system for any man to do with his might what his hand found to do?

THE BONUS SYSTEM.

Another fundamental feature of scientific management which is much bragged about is the "bonus system of rewarding labor." A self-respecting workman never wants to be rewarded, but just honestly paid for his work. The bonus system dodges the honesty. It is a singular fact that, so far as I know, only machinists and workers in trades allied to them, have been regarded as such simpletons as to make it safe to propose the bonus system to them. Of course, no one has ever had the hardihood to propose the bonus system of rewarding labor to the collar girls of Troy, to the glove workers of Gloversville, to the hat makers at Danbury, at the knitting mills of Cohoes, the textile mills of Lowell, Lawrence and Fall River, nor among the garment workers of New York. In such places as these the worker is paid for just what he does, and according to the amount of work accomplished. If he is paid a certain sum of money for a specified quantity of work he is paid 50 per cent. more money for 50 per cent. more work, and so on according to the work done.

Under the bonus system a certain rate of pay is fixed for a certain amount of work done in a given time, say a day; then if the man does more than the stipulated amount in the given time, entirely through his own exertions and with the employer getting the benefit of the increased productivity of his plant, he is not paid at the same rate for the additional amount of work done, but is given a "bonus" amounting usually to one-half—sometimes less and seldom more—of the additional amount fairly earned. To put it in plain figures: if a man is paid $3 for producing 100 pieces of a certain product in a given time, he should be paid $4.50 if he produces 150 pieces in the same time; and he would be paid at that rate under the system ruling in the factory towns above mentioned. Under the "bonus system for rewarding labor" he would be paid $3.75 or less. It is astonishing that such a system should have had even temporary acceptance anywhere. If I misrepresent the system in any way I would be glad to be cor-

rected. If the system is essentially honest I would like to have it proved to me.—*Machinery.*



AUTOMATIC SAND BLAST MACHINE

The half-tone above shows an automatic machine specially designed for handling small castings designed by the W. W. Sly Manufacturing Company, Cleveland. It consists of a slowly rotating table half of which is constantly enclosed in a chamber where moving sand blast nozzles play on the work to be cleaned. In the smaller sizes of this machine two nozzles are used and in the larger sizes there are four, and these move about so that all the castings get their share of the abrasion.

The machine works on the gravity system, and is connected to a Sly dust arrester which removes flying particles of sand and dirt. A split rubber curtain across the front of the machine protects the operator from the dust and at the same time allows the castings to pass by easily. The table is built with heavy cast iron arms held in place by a forged steel ring. The grates composing the top of the table are made in sections so that they may be easily removed. The sand hopper is cast iron and the movement of the hoppers is taken from the main drive. The used sand falling through the table into a steel hopper drops from there into the boat of a bucket elevator which returns it to the feed hopper.

HARDNESS OF STONE

There have been constant calls for some test that would show the hardness of stone and the ease of working. It is popularly supposed that hardness, ease of working and strength are synonymous, or at least very intimately connected. This is not so, except in a very general way, with regard to stone. The stone that shows by far the highest crushing strength of any ever tested in this country, a Southern granite, is not particularly hard, and is easy to work. On the other hand, there are stones of low crushing strength that are very hard and refractory. As yet no satisfactory method of testing the hardness of stone and the ease of working has been adopted, although several methods have been suggested. Every authority agrees upon the desirability of such a test.

There is now in existence a scale of hardness as applied to the non-metallic minerals that has been in use for some years, is recognized as standard, and has proved of great value. This is known as Moh's Scale, and is graduated as follows:

1. Talc.
2. Gypsum or rock salt.
3. Calcite.
4. Fluorite.
5. Apatite.
6. Orthoclase.
7. Quartz.
8. Topaz.
9. Sapphire or corundum.
10. Diamond.

Any member of the series will scratch any of the others below it. Talc is readily scratched by the finger-nail, and gypsum with difficulty. By this scale it will be seen that the hardness of granite, for instance, is between 6 and 7. But it is apparent that any such scale as this will not serve to register the comparative hardness of the different varieties of granite, or of any other stone.

THE MINER

He must work in gas and see in the dark,
The music he hears is the air-drill's bark,
It isn't no picnic in the park,
    It isn't no cinch he's stole!
He's carpenter, plumber, machinist, yes,
A sort of surveyor, too, I guess,
A little of everything more or less,
    The miner who digs the hole!

—*Berton Braley.*

NEW COMMERCIAL OXYGEN PLANT

The Linde Air Products Company, Forty-second Street Building, New York City, is to erect its twelfth commercial oxygen plant in Philadelphia. The building will be one story high, fireproof throughout, of brick, steel and concrete. Its equipment will comprise the special Linde rectifying apparatus, air compressors, oxygen pumps, etc., all electrically, individually operated. The Linde company, in the sure anticipation of large increases in the sale and use of oxygen, is allowing ample space for doubling the capacity of the plant which, to begin with, will be capable of putting out 2,000,000 cubic feet of oxygen per month. In the past two years the company has built nine plants, and others are in contemplation. In furnishing oxygen with as little expense for transportation as possible, and at prices which make it readily available, it is doing valuable service in the promotion of the use of oxygen processes.

NOTES

All hoists, save the Sacramento, at the Copper Queen mines, Arizona, are operated by compressed air, generated at the central power-plant, by machines having a total capacity of 21,000 cu. ft. of free air per minute.

The nominating committee of the American Institute of Mining Engineers has made the following nominations for officers of the Institute to be voted for at the annual meeting in 1915: For president, William L. Saunders, district O. For vice-presidents, Sidney J. Jennings, district O; and Philip N. Moore, district 3. For directors, Samuel A. Taylor, district 2, Robert W. Hunt, district 3; Hennen Jennings, district 9; George C. Stone, district O; and W. H. Aldridge, district 6. William J. Cox is chairman of the committee.

The Yale "Bowl" has 30 tunnels for the entrance of spectators to the ring of seats. They are each 7 ft. wide and 8 ft. high inside and about 140 ft. in length. There is also one tunnel to the arena 15 by 10 ft. and a players' tunnel 10 by 8 ft.

The Lidgerwood Manufacturing Company, New York, probably hold the record for hoisting machinery. In their forty odd years of business they have built more than 37,000 steam, compressed air and electric hoists. Some of them still running have been in use more than thirty years although great improvements are shown in the later machines.

Inventors are to have a show all their own at the Grand Central Palace during the week beginning December 12. It will be known as the International Exposition of Inventions, and the inventors exhibiting the children of their brains will attempt to get into touch with men of capital who will adopt them.

The New Zealand Sulphur Co. has spent about $100,000 in preparations for mining sulphur on White island, a volcanic area in the Bay of Plenty of the North Island, but during September it was found that the camp had been demolished and 10 men killed by the collapse of a high cliff; probably by some volcanic disturbance.

The largest pneumatic caisson job in Canada has recently been completed for the Montreal Customs Warehouse by the Foundation Company. One hundred and thirty-two piers were sunk, and an unusual feature of the job occurred in placing the concrete, which work was carried on while the temperature was 30 degrees below zero.

According to the official statement of the British War Office, their aviators are covering an average of 2,000 miles a day. Up to September 21st they had flown 87,000 miles and remained 1,400 hours in the air. By now these figures have been trebled. A certain French corps commander's opinion is that a single aeroplane is as valuable as an entire division of cavalry.

Perhaps one of the most interesting, as well as one of the least known phases of the oil

industry in California, is mining for oil in Sulphur mountain and elsewhere in Ventura county and in the Coalinga field by tunnels driven into oil-bearing strata. The oldest of these tunnels, which was dug in 1861 and produced at first about 60 barrels of high gravity oil a day, is still yielding small quantities of oil and considerable water.

The Institution of Engineers of the River Plate, with offices at 195 Cinco de Mayo, Buenos Aires, Argentina, will be glad to file any catalogs or circulars on engineering subjects which manufacturers may send. The Institution library has facilities for storing and classifying these documents, and they will be consulted by members.

The first New York subway was opened to the public ten years ago. To the close of the last fiscal year, June 30, 1914, the subway has carried 2,332,401,305 passengers, an average of more than 233,000,000 passengers per annum, the present week-day number being approximately one million. The total operating revenue for the same period was $120,084,198, and the operating expenses and taxes $49,549,845. The rental paid to the City amounted to $20,421,069.

Among the exhibits of the firm of Piccard, Piccet & Co., Geneva, Switzerland, at the Swiss National Exposition being held at Berne, Switzerland, is an impulse wheel built for the Fully high head plant of the Société d'Electrochimie, a French company. This is a horizontal shaft wheel which will develop 3000 hp. at 500 r.p.m. Its wheel diameter is 11½ ft. and the jet diameter is 1½ in. The Fully plant will have the highest head water power in the world by a considerable margin.

In an investigation of the use of electricity in coal mines, reported to the British Association by Dr. W. M. Thornton, it was found that electric bells often produce sparks at trembler or push button, and that these have sufficient intensity to fire mine gases or coal dust. He would enclose all electric lamps, fuses, etc., even the smallest. Not all sparks are dangerous, however, and gas could not be ignited with the blue brush discharges from a high-speed belt.

With the submarines and the air craft sharing the glories of the world's butcher carnival it would have been strange if subterranean devices also had not been heard from. We are told that at one point where the opposing trenches are very close to each other, and where the French were "much annoyed" by the fire of a German machine gun which was otherwise inaccessible, some men who had been recruited from the coal mines drove a tunnel to the spot and blew up the nuisance.

The application of varnish by means of an air spray has heretofore been attended with considerable difficulty on account of the tendency of the varnish to stiffen and turn white when it struck the surface being coated. This has apparently been overcome by the simple expedient of putting an electric heater in the pipe that furnishes the compressed air for forming the spray. With the air heated in this way the varnish flows freely through the orifices of the air brush, and dries quickly and smoothly.

A new process for popping corn has been introduced by a recently patented machine which causes the kernels to explode by producing a pressure within them through the application of heat while they are maintained under less than normal atmospheric pressure. By creating a partial vacuum in the popper, the moisture in the kernels is changed into steam at a lower temperature than could be accomplished under ordinary pressure. In this manner a larger quantity of water is converted into steam at the moment of popping, while, the atmospheric pressure being below normal, the resulting explosion fluffs the corn greatly.

The deplorable disaster at the mine of the Franklin Coal & Coke Co., near Royalton, Ill., in which at least 50 lives were lost, is claimed to have been due to an explosion that resulted when a miner's lamp came in contact with a pocket of gas that had been noted the night before by a mine examiner and marked dangerous. The precautionary action of reversing the ventilating fan to suck out black damp after the fatal explosion is claimed by state mine examiners to have saved 285 men who were scattered through the underground passages and finally made their way to the open air.

La Paz, Mexico, is the chief pearl-fishing center of the Pacific coast of America, ranking third on the globe, with $2,000,000 as the value of the annual export. The mollusks found there are never seen in beds, like the edible oyster, but must be sought singly by divers. The shells are often fifteen inches across, and these produce mother-of-pearl. As an occupation, pearl fishing is slow suicide, but nearly all the 6,600 inhabitants of La Paz are engaged in it. Deafness is followed by nervous prostration, and it is rarely that a diver can hold out more than five years at this strenuous occupation.

The United States Bureau of Mines has begun the collection of a general library of petroleum literature, under the direction of W. A. Williams, chief petroleum technologist. The details of this work have been assigned to Dr. David T. Day, who has recently been transferred from the United States Geological Survey as petroleum technologist, and who will also assist in a thoroughly organized research into the chemistry of oils, which is being developed by the Bureau of Mines. The importance of such a library is so manifest that it is hoped all technologists will aid in the work by exchanging with the bureau all available books and maps on this subject.

Extremely high temperatures are being obtained by combining a jet of air or oxygen or an oxyacetylene or oxyhydrogen flame with an ordinary electric arc. The simplest form of the apparatus used for this purpose has a hollow carbon electrode through which a blast of air or oxygen is blown inside the electric arc. The metal to be heated forms the positive pole and the carbon electrode the negative pole. It is said that the gases burning within the arc produce a temperature greatly in excess of that produced by the electric arc alone. Other forms of apparatus are used in which an oxyacetylene or oxyhydrogen flame is projected upon the electric arc.

In the course of his last annual report, the Boksburg (South Africa) Inspector of Mines says that towards the latter end of the year two light hammer water rock-drilling machines, viz., the Leyner and the Atlas drills, were introduced into some of the mines. From figures kindly given by the managers using the drills the results are extremely satisfactory. The drills have many advantages over the piston drills in that they weigh only about one-third, require fewer persons to run them and above all it is impossible to work without water, which is fed to the face of the bit through hollow steel. All the drills are star bit and the holes consequently start at a smaller diameter and finish up only slightly less.

At the Turkey Creek pumping station, Kansas City, Mo., ash handling by vacuum conveyor cost $6.40 per day less than by the former system of hand removal. The plant, installed by the Green Engineering Company, 50 Church St., N. Y., removes ashes from the ash pits in the basement to a tank from which they feed by gravity into railway cars. The railroad pays $6 per car for the ashes. The guaranteed capacity of 250 lb. per minute was exceeded in test by 20 lb. Two men remove all ashes, load cars, clean the machine and take general care of the boiler-room basement. Costs of operation during 178 days were $712 for labor and $37.19 for repairs. Against this are receipts for $186 for 31 cars sold, a figure balanced by the estimated cost of power for running the machinery three and one-half hours per day. By the old method five men and a mule would have cost $1,886.80.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 6.

1,112,481. AUTOMATIC BRAKE MECHANISM FOR TRAINS. JOHN SAMUELS, Rock Slope, Ala.

1,112,493. QUICK-ACTION TRIPLE-VALVE DEVICE. WALTER V. TURNER, Edgewood, Pa.

1,112,494. COMBINED AUTOMATIC AND STRAIGHT-AIR BRAKE. WALTER V. TURNER, Edgewood. Pa.

1,112,495. DUPLEX-PRESSURE ELECTRIC PUMP-GOVERNOR. WALTER V. TURNER, Edgewood, Pa.

2. The combination with a pump governor normally operated according to the degree of pump pressure for cutting the pump into and out of action, of a valve device for supplying fluid to the pump governor at a pressure less than the pump pressure, to thereby cause the governor to cut the pump into and out of action at pump pressures in excess of the pressures for which the governor is adjusted.

1,112,496. ART OF MAKING CASTINGS. WILLIAM C. URBAN, Granite City, Ill.

In the art of making castings, the process which consists in confining molten material in a primary and a secondary compartment, the latter being provided with an admission port through which molten material may flow from

the primary compartment and with a discharge port through which the molten material is discharged; closing said discharge port to prevent the escape of molten material from the secondary compartment, opening and closing the admission port while the discharge port is closed, introducing fluid under pressure into the secondary compartment, and opening and closing the discharge port while the admission port is closed.

1,112,563. PNEUMATIC PISTOL. DANIEL R. SACKMAN, Cleveland, Ohio.

1,112,636. AUTOMATICALLY CLOSING AND OPENING RECEPTACLES. THOMAS W. MCNEILL, Chicago, Ill.

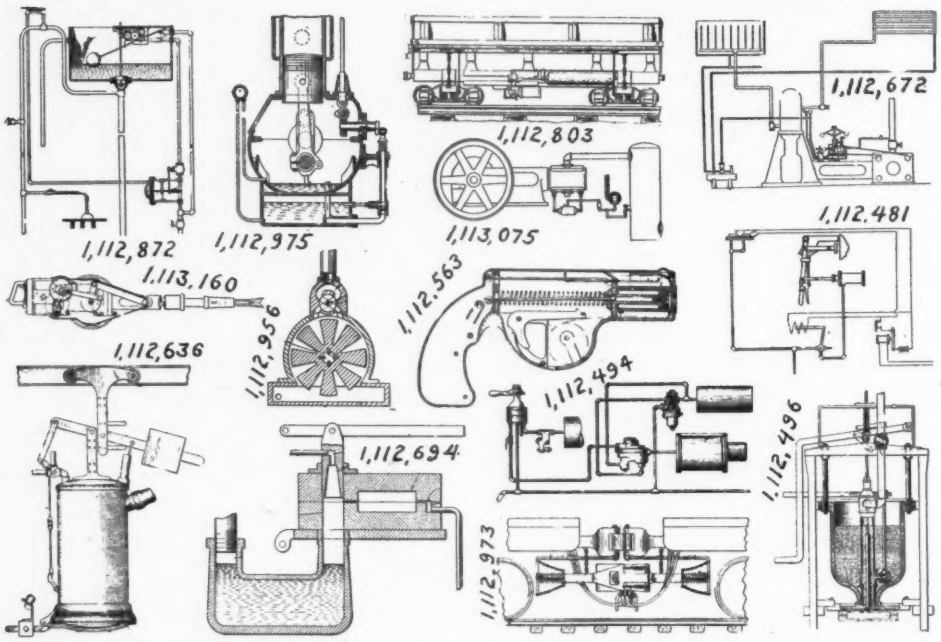
1,112,672. SAFETY APPLIANCE FOR AMMONIA-COMPRESSORS. ALBERT L. BROWN, Little Rock, Ark.

1,113,077. AIR-GUN. BYRON WILLETT, Plymouth, Mich.

1,113,155. FLUID-MOTOR. WILLIAM P. ESPY, Springfield, Ohio.

1,113,160. MINING-MACHINE. GEORGE E. LYNCH, Columbus, Ohio.

1. The combination of a frame, a reciprocating tool mounted on the frame, a piston connected to the tool, an air compression cylinder in which said piston works, a toggle lever system connected to and adapted to retract the tool and piston, an electric motor mounted on the said frame, and power transmitting devices between the motor and toggle lever system adapted to convert the continuous rotation of the motor into a reversing or oscillatory movement of the toggle levers, said transmission devices comprising parts having a lost motion connection.



PNEUMATIC PATENTS OCTOBER 6.

1,112,694. ART OF MAKING CASTINGS. CHARLES M. GREY, East Orange, N. J.

1. In the art of making die castings, the improvement which consists in introducing metal from a reservoir into the die and utilizing the flow of metal to compress the air or gases and to force the same into a chamber separate from the die.

1,112,803. CUSHIONING DEVICE FOR AIR-CYLINDERS OF DUMPING-CARS AND BRAKES. WILLIAM D. JONES, Patillas, Porto Rico.

1,112,872. VACUUM SYSTEM. JULIAN N. WALTON, Brooklyn, N. Y.

1,112,956. TWIN VACUUM-TURBINE. PETER F. WHITE and MERCER M. LEONARD, Leavenworth, Kans.

1,112,973. AUTOMATIC AIR-BRAKE HOSE-COUPLING FOR CARS. EDWARD J. BRICKER, Minneapolis, Minn.

1,112,975. OIL-DISTRIBUTING MECHANISM. ALANSON P. BRUSH, Flint, Mich.

1,113,075. CONTROLLING DEVICE FOR FLUID-COMPRESSORS. CHARLES WAINWRIGHT, Erie, Pa.

OCTOBER 13.

1,113,257. METHOD AND MEANS FOR AUTOMATICALLY APPLYING DIFFERENTIAL AIR-PRESSURE TO COMPARTMENTS OF SHIPS. FRANK JULIAN SPRAGUE and FRANK DESMOND SPRAGUE, New York, N. Y.

1. The combination with the fluid tight compartments of a vessel, of means for supplying compressed air to the several compartments, and reversibly operative means capable of effecting automatic differentiation of the air pressures therein in accordance with their respective distances from an injured compartment.

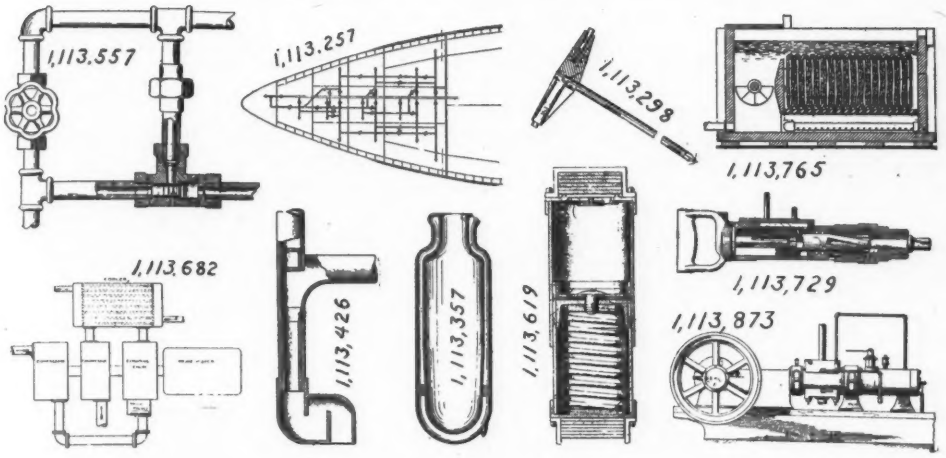
1,113,298. PNEUMATIC AGITATOR FOR ICE-MAKING APPARATUS. FRANK L. BERRY, Spokane, Wash.

1,113,314. AIR - BRAKE - CONTROLLING MECHANISM FOR BLOCK-SIGNAL SYSTEMS. DAVID DALE, Chicago, Ill.

1,113,357. VACUUM-BOTTLE. JOSEPH F. LAMB, New Britain, Conn.

1,113,370. PNEUMATIC SPRING FOR VEHICLES OR SHOCK-ABSORBERS. WILHELM L. OSTENDORF, Wilkinsburg, Pa.

1,113,426. SUCTION APPARATUS. ROBERT GALLOWAY, Buffalo, N. Y.



PNEUMATIC PATENTS OCTOBER 13.

1,113,557. SANDING DEVICE. ALBERT EDMUND HUDSON, Calgary, Alberta, Canada.

1,113,619. SHOCK-ABSORBER. CHARLES H. HAMMERSMITH, Brookfield, Ill.

1,113,682. GAS DESICCATION. JOHANN F. M. PATITZ, Milwaukee, Wis.

1,113,729. PERCUSSIVE TOOL. JOHN U. ADOLPH, Easton, Pa.

1,113,765. DYEING PROCESS. JAMES J. FEARON, Philadelphia, Pa.

1. As an improvement in dyeing skein yarn with sulfur dyes, the mode herein described, which consists in first subjecting the yarn to the action of a liquid dye bath, and then aerating a liquid bath in which the yarn is contained by passing air through said bath.

1,113,873. MEANS FOR COOLING THE VALVE-CHESTS OF AIR-COMPRESSORS. CLEMENT W. BORING, Bradford, Pa.

1,113,902. PROCESS OF TREATING TOBACCO. LEO W. LAWRENCE and FREDERIC F. BAHNSON, Winston-Salem, N. C.

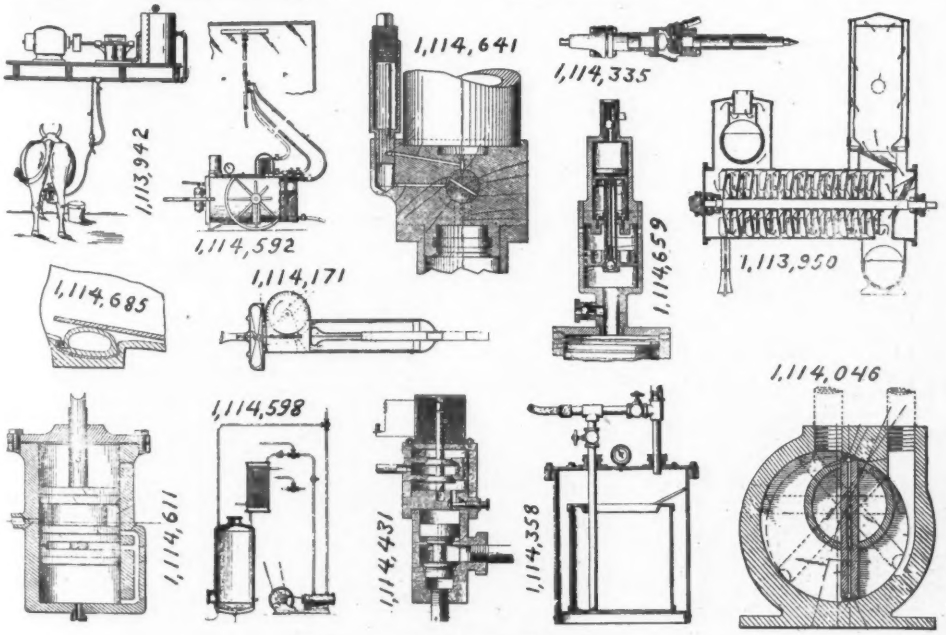
4. The process of artificially aging tobacco, which consists in subjecting it to the action of a maintained highly humid atmosphere, then subjecting it to the action of an atmosphere of maintained relatively low humidity, and then repeating these steps in order until the tobacco is properly aged.

OCTOBER 20.

1,113,942. MILKING-MACHINE. OSCAR ANDERSON, Newark, N. J.

1,113,950. AIR-CONDITIONING APPARATUS. ALLEN A. BLOMFELDT, Chicago, Ill.

1,114,046. VACUUM-PUMP. AMANDUS C. ROESSLER, Mineola, N. Y.

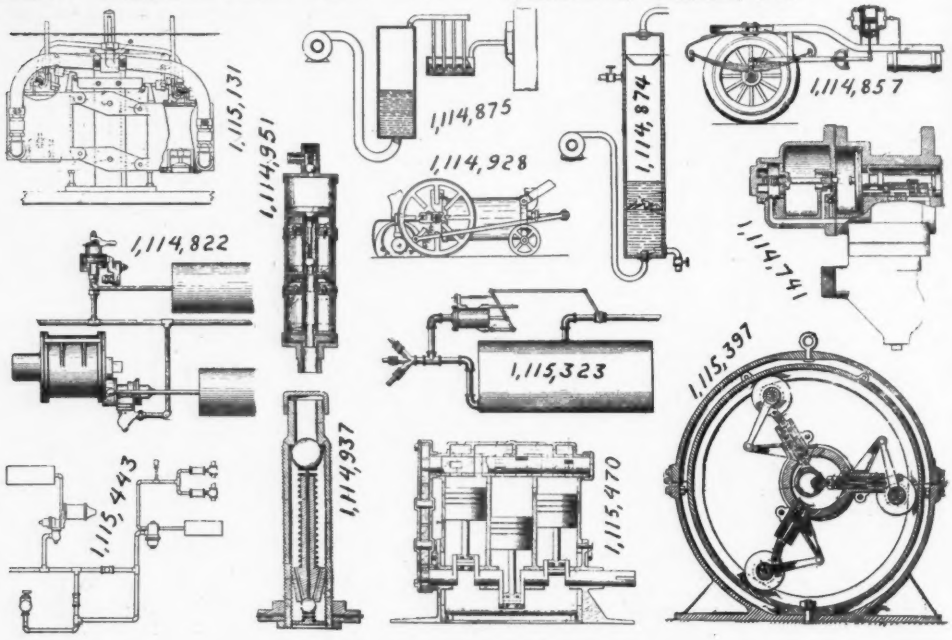


PNEUMATIC PATENTS OCTOBER 20.

1,114,059-60. SUCTION CLEANER AND DUST-SEPARATOR. IRA H. SPENCER, Hartford, Conn.
1,114,075. PERCUSSIVE HAMMER, DRILL, AND THE LIKE. WILLIAM HENRY WAKFER, South Norwood, England.
1,114,126. MEANS FOR DISTRIBUTING OXYGEN. ALEXANDER BERNHARD DRAGER, Lubeck, Germany.
1,114,152. AIR-BRAKE APPARATUS. FRANK KOSIER and THOMAS R. KOSIER, Ludlow, Ky., and THOMAS BEMIS, Indianapolis, Ind.
1,114,155. APPARATUS FOR RAISING SUBMARINES AND SUBMERSIBLES. LUCIEN AUGUSTE JOSUE LEDUC, Tours, France.
1,114,171. PNEUMATIC CLEANER. HUBERT MEREDITH-JONES, New York, N. Y.
1,114,285. PNEUMATIC SPRING FOR VEHICLES. WILLIAM K. OMICK, Detroit, Mich.
1,114,335. PRESSURE-FLUID TOOL. LEWIS C. BAYLES, Johannesburg, Transvaal, and ALBERT H. TAYLOR, Easton, Pa.
1,114,358. COMPRESSION-TANK. JOSEPH L. HOOKER, Anderson, Ind.
1,114,421. PNEUMATIC PIANO-PLAYER. FREDERICK W. WINTER, San Francisco, Cal.
1,114,431. PNEUMATICALLY-TIMED AIR-VALVE. CLINTON L. BOPP, Hawkeye, Iowa.
1,114,592. HYDROPNEUMATIC WINDOW-CLEANING APPARATUS. CLINTON C. DEWITT, Shrewsbury Park, Mo.
1,114,598. PROCESS FOR THE EXTRACTION OF FAT FROM BONES, MATERIALS SUITABLE FOR GLUE MANUFACTURE, AND LIKE SUBSTANCES. ERNST FISCHER, Charlottenburg, Germany.
1,114,641. APPARATUS FOR LUBRICATING PNEUMATIC DRILLS. VINCENT J. O'BRIEN and GEORGE A. OLIVER, Denver, Colo.
1,114,642-3. APPARATUS FOR ELECTRICALLY CONTROLLING AIR-BRAKES. EDWARD L. ORCUTT, Somerville, Mass.
1,114,644. SPEED-REGULATING MECHANISM. EDWARD L. ORCUTT, Somerville, Mass.
1,114,659. FLUID-PRESSURE-DRIVEN PUMP. CARLEY GOULD WELD, North Chatham, Mass.
1,114,671. BELL-RINGER. CHARLES A. BATES, Marshalltown, Iowa.
1,114,685. PNEUMATIC HEEL FOR BOOTS AND SHOES. GEORGE TERRY TRIST FREEMAN, Southsea, England.

OCTOBER 27.

1,114,741. TRIPLE-VALVE DEVICE. FRED B. FARMER, St. Paul, Minn.
1,114,822. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.
1,114,857. AIR-COMPRESSING SHOCK-ABSORBER. JOHN J. CAMPODONICO, Stockton, Cal.
1,114,874. DEVICE FOR TREATING LIQUIDS. ARTHUR O. FOX and RUSSELL R. BATES, Madison, Wis.
1,114,875. PROCESS OF TREATING LIQUIDS. ARTHUR O. FOX and RUSSELL R. BATES, Madison, Wis.
1,114,928. SUCTION-SWEEPER. FREDERICK STEINKOENIG, Cincinnati, Ohio.



PNEUMATIC PATENTS OCTOBER 27.

1,114,937. VALVE FOR PNEUMATIC TIRES. EDWARD TESSNER, Milwaukee, Wis.
1,114,949. ROCK-DRILL. DANIEL S. WAUGH, Denver, Colo.
1,114,951. POWER FLUID-ACTUATED IMPULSE-PUMP. CARLEY GOULD WELD, North Chatham, Mass.
1,115,131. PNEUMATIC WATER-ELEVATOR. EDWIN E. THOMAS, Portland, Oreg.
1,115,286. ELECTROPNEUMATIC AIR-BRAKE SYSTEM. JOHN PATRICK COSTELLOE, Medicine Hat, Alberta, Canada.
1,115,323. FLUID-PRESSURE REGULATOR. LEWIS S. MANSPERGER, Troy, Kans.
1,115,367. PRESSURE-REGULATING AIR-CIRCULATING SYSTEM FOR SUBMARINES. THEODORUS J. P. AANSTOOTS, Passaic, N. J.
1,115,397. ROTARY AIR-MOTOR. LEROY CLAWSON, Hall, Mont.
1,115,435. TIRE-INFLATING PUMP. WILLARD S. JOBES, San Antonio, Tex.
1,115,443. AUTOMATIC TRAIN-STOP. FREDERICK I. LEACH, Lynn, Mass.
1,115,470. AIR-MOTOR. CARL E. L. LIPMAN, Beloit, Wis.

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Vol. XIX DECEMBER, 1914 No. 12

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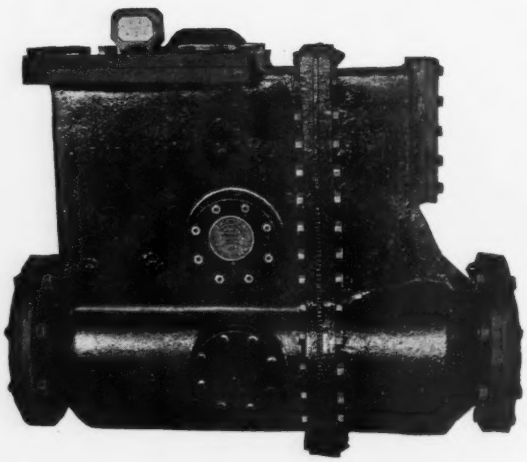

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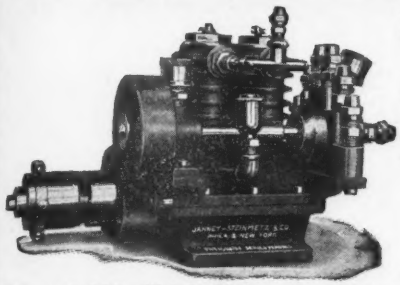

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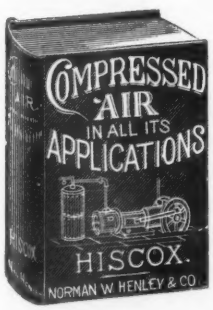
By Gardner D. Hiscox



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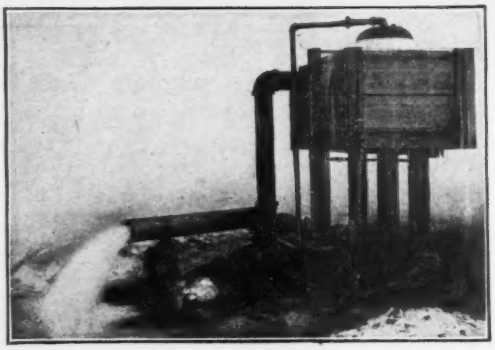

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No. of wells	1	% Submergence	75
Diameter	8"	Constant	242
Depth pump	208'	Gallons discharged into Reservoir per minute	819
Starting pressure	85	Gallons overflow per minute	800
Running pressure	72	Total gallons	1619
Shut in pressure	70	Air used 12x12x16 R. C. 92 R.P.M. P. D.	192
Submergence	161		
Pumping head	47		
Elevation	6		
Total lift	53		

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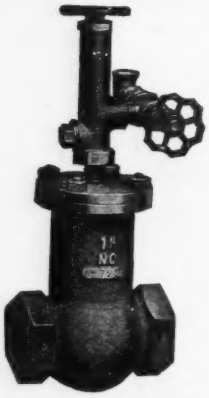

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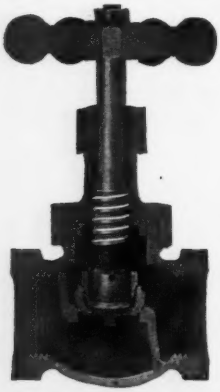

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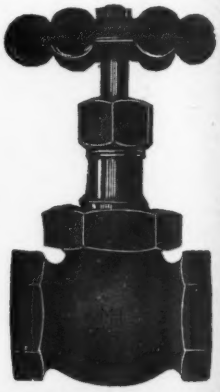

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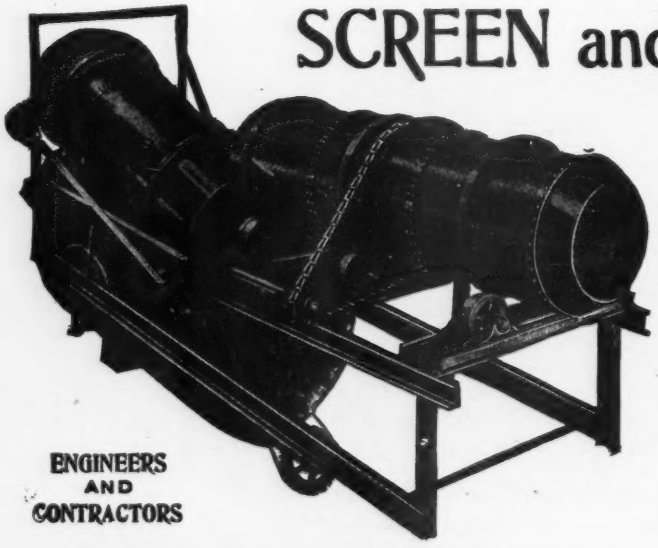

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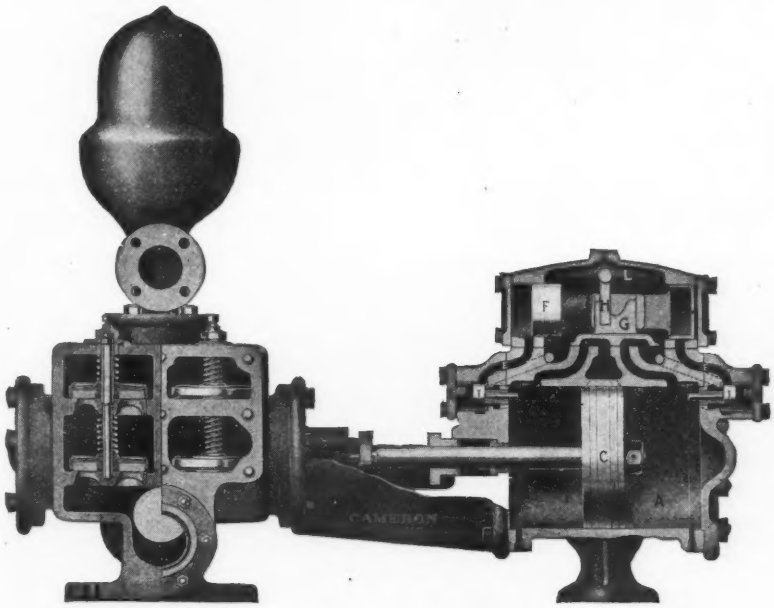

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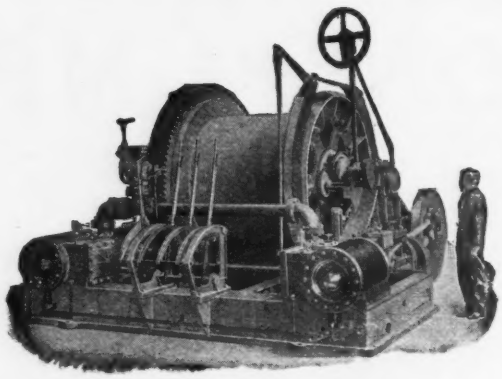

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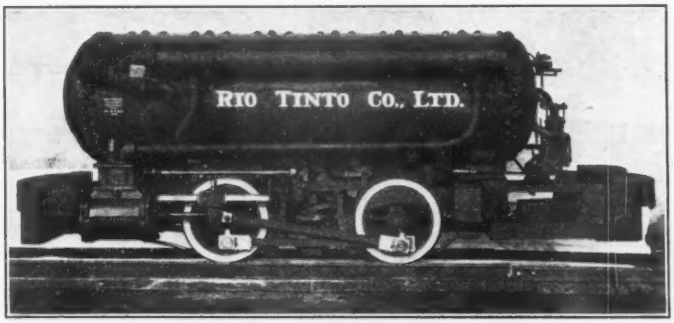

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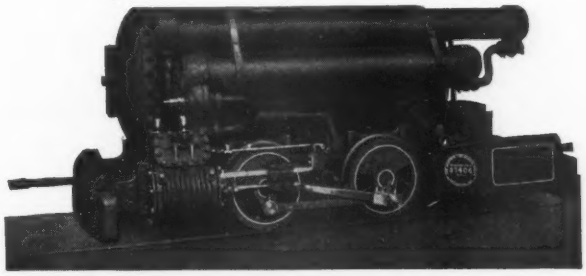

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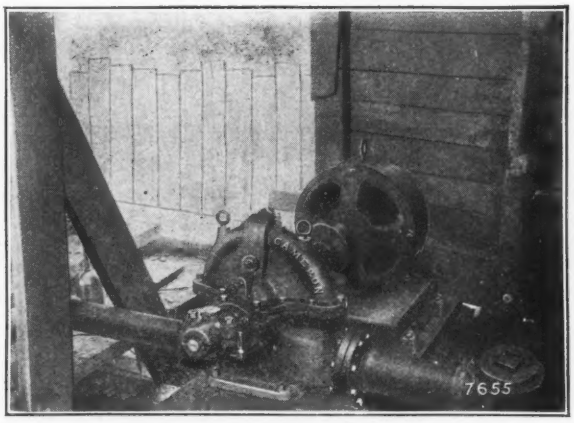

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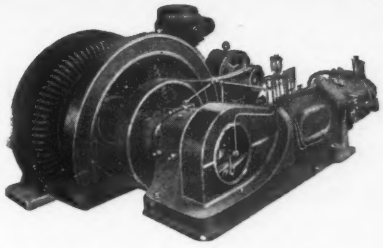

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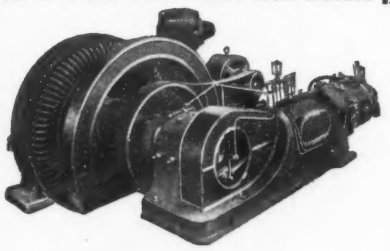

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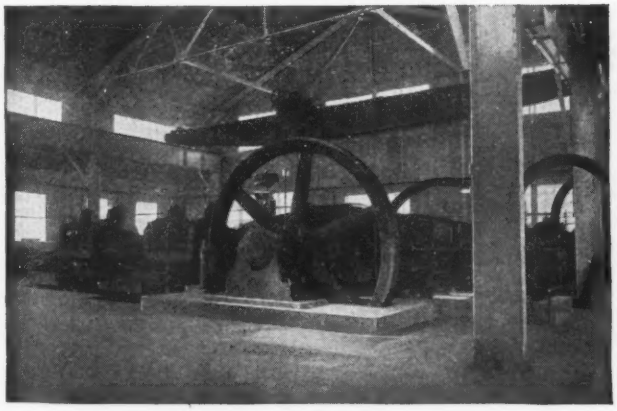

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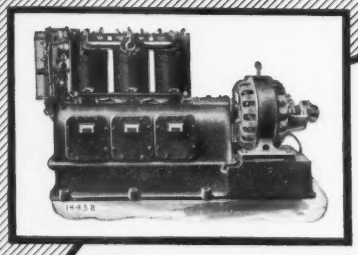

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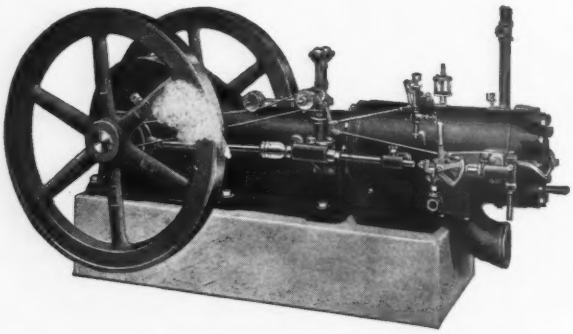

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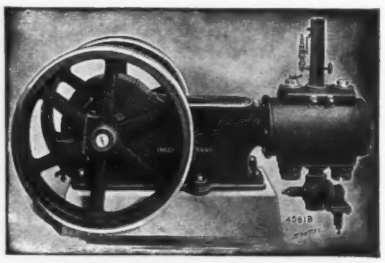

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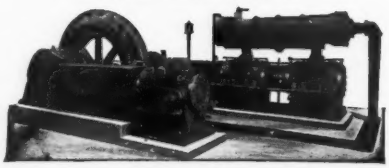

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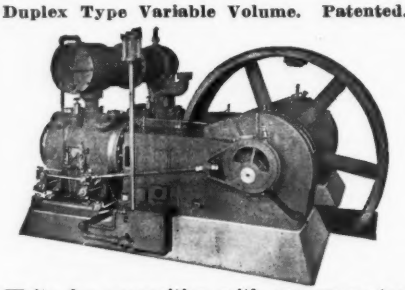

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